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Introduction

We, the editors of this volume, are happy and honored to present the reader with these Proceedings of Sinn und Be-deutung 20 (SuB 20). This volume contains a collection of papers which were presented at the main session, the STECHOW Workshop and the Workshop "Experimental Methodology in Semantics and Pragmatics" during the 20th jubilee meeting of SuB. SuB 20 was held on September 8th – 12th 2015 in the town of Tübingen at the Eberhard Karls Universität, back where it began in 1996. A little bit of history is in place here: Sinn und Bedeutung is an annual conference organized by the Gesellschaft für Semantik which was founded in 1994 during the Workshop on Recent Developments in the Theory of Natural Language Semantics in Blaubeuren by Sebastian Löbner, Arnim von Stechow und Thomas Ede Zimmermann. Over the course of its existence, SuB has become one of the most renowned conferences in the field of formal semantics worldwide, has brought together researchers and has advanced the devel-opment of semantic theory in crucial ways. In order to honor one of the founding fathers of the conference, Arnim von Stechow, a special workshop was organized. The (first part of the) title of the workshop STECHOW (Semantic Theory Evolves Continuously – Here's Our Workshop) summarizes the achievements of Arnim von Stechow who is surely one of the reasons why "semantic theory evolves continuously" (see esp. Barbara Partee's paper in this vol-ume for the historical context of Arnim von Stechow's contributions). Both the talks of the invited speakers and the poster session were a huge success! The fact that semantic theory evolves continuously is reflected by new trends in semantics, especially fruitful collaborations of semanticists with psychologists, cognitive scientists, neurologists etc. New questions arise with new experimental and cross-linguistic data, some of which also found their manifestation in intriguing discussions during the Workshop on Experimental Methodology. A total of 48 papers are collected in this proceedings volume, which appears online at:

semanticsarchive.net

The editors of this volume would like to thank the authors for their contributions and all the anonymous reviewers for their collaboration. We also wish to thank our fellow organizers, Sigrid Beck, Pritty Patel-Grosz, the organizers of the STECHOW Workshop Doris Penka and Sarah Zobel, the organizers of the Experimental Methodology Work-shop Oliver Bott, Robin Hörnig, Janina Radò and Sonja Tiemann, the invited speakers Sigrid Beck, Irene Heim, Luisa Martì, Barbara Partee, Uli Sauerland, Viola Schmitt and Junko Shimoyama. We also thank our secretary Beate Starke and all our wonderful helpers, Julia Braun, Saskia Brockmann, Julia Chant, Sehriban Erbektas, Holger Gauza, Hannah Gerbrich, Sonja Haas-Gruber, Matthias Holweger, Nadina-Rozalia Kiss, Dina Lausch, Johanna Lechner, Ma-rina Lieb, Anne Mahlke, Carolin Munderich, Kalle Müller, Lena Naumann, Birgit Rapp, Konstantin Sachs, Vivian Schreier, Achim Skuta, Melanie Störzer, Simeon Wiehl, Alexander Wimmer, Karolin Wurster, and all others involved for contributing to the success of this conference.

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STECHOW WORKSHOP

Temporal *noch/still* and further-to readings of German *noch*

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Abstract: In this paper I propose an analysis of temporal *still* and its German counterpart *noch*. The proposal unifies earlier analyses e.g. of 'it is still raining', 'it is still 8am'. It is then applied to so-called further-to *noch* in German as in 'Ich gehe noch einkaufen' (lit.: 'I still go shopping' = 'I will just quickly go shopping'). The proposal highlights the interesting interaction of syntactic structure, presupposition, implicature and focus in such sentences.

Keywords: *noch*, focus, scalar implicatures, presupposition

1. Introduction

This paper presents an analysis of the so-called 'further-to' reading of the German scalar particle *noch* 'still' according to which it is an instance of a normal temporal reading of the particle. An example of temporal *noch/still* is given in (1). Its interpretation is sketched informally in (1'). The English particle *still* and its German counterpart *noch* share this interpretation.

(1)	Martin schläft noch.	(temporal *noch/still*)
	Martin sleeps still	
	'Martin is still asleep.'	

(1')	(i)	Martin is asleep.
	(ii)	Martin has been asleep earlier.
	(iii)	Martin might not be asleep later.

In (2) I provide an example of further-to *noch*. The term comes from Klein (2007/2015). This use of the German particle is not shared by English *still*. The contribution of the particle is hard to pin down; (2') suggests an appropriate context.

(2)	Ich	gehe	noch	(eben)	einkaufen.	(further-to *noch*)
	I	go	still	(just)	shopping	
	'I will just quickly go shopping (before...)'					

(2')	I will go shopping now, and then we can move on from doing chores to some fun activity.

My goal is to present a compositional semantic analysis of the further-to reading. This analysis will use the same semantics of the particle as (1). The interpretive effect of *noch* is quite different

in (2) than in (1) because in (2), *noch* does not modify the main predicate of the clause. Instead, I argue that it is an instance of subconstituent modifying *noch*, similar to (3).

(3)   Lynn Hill hat noch   am 23.   den   Gipfel   erreicht.
        Lynn Hill has still   on the 23rd   the   summit   reached
    ?   'Lynn Hill reached the summit still on the 23rd.'

(3')   (i)   Lynn Hill reached the summit on the 23rd.
        (ii)   There are earlier times that are on the 23rd.
        (iii)   Later times might not be on the 23rd.

This is not immediately obvious in (2) because the subconstituent in further-to uses of *noch* may be silent. The further-to reading arises when *noch* combines with an overt or covert time adverbial denoting an interval surrounding the topic time of the sentence.

The following sections spell out this idea. In section 2 I introduce the analysis of normal temporal *noch/still* that I adopt. In section 3 I discuss the interpretation of sentences in which the particle modifies a subconstituent instead of the main predicate of the sentence. I extend this analysis to further-to *noch* in section 4. Effects of focus in such sentences are discussed in section 5. Section 6 wraps up the paper.

2. Temporal *noch/still*

We begin with fairly straightforward and well-described continuative uses of *noch/still*; another example is given below. Where English and German are the same, I present the data simply as a pair, as in (4), for convenience. Intuitively (4) contributes the meaning components in (4').

(4)   Es regnet noch.
        It is still raining.

(4')   (i)   Assertion: It is raining.
        (ii)   Presupposition: It rained at the relevant preceding time.
        (iii)   Implicature: It might stop raining./It will stop raining.

Let's begin with the first two, the presupposition (ii) and assertion (i). Their combined interpretive impact is sketched in (5).

(5)   'rain' is true of the utterance time, and 'rain' was true of an earlier abutting time
        interval.

$$t_{now}$$
$$\text{----------------------------|------|-------------->}$$
$$\text{//////////////////////}$$
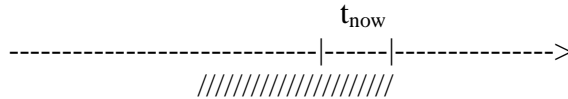
In my analysis of temporal *noch/still*, I use the lexical entry in (6) for the scalar particle. See e.g.
Löbner (1990) and Ippolito (2007) for predecessors and discussion. The interpretation resulting
from this semantics is sketched in general terms in (7). I refer to P as the predicate, to t as the
argument and to t* as the anaphoric element. The scalar alternatives become relevant below.

(6) $[[\textit{noch/still}_<]] = \lambda t^*.\lambda t.\lambda P_{<i,t>}:t^* \propto t \,\&\, P(t^*).P(t)$ (type $<i,<i,<<i,t>,t>>>$)

(7)   The scale is temporal order "$<$" (type $<<i,<i,t>>$).

        (i)   Assertion: P(t) - P is true of t
        (ii)   PSP: $t^* \propto t \,\&\, P(t^*)$ - the relevant other time t* left-abuts (immediately
                         precedes) t and P is true of t*
        (iii)   Scalar alternatives: $\{P(t') \mid t' \in Alt(t)\}$
                                         "What times t' is P true of?"

I associate the example with the LF in (8). I assume (quite standardly; see e.g. von Stechow &
Beck (2015) and the literature cited there) that an Aspect Phrase AspP dominates VP, which
denotes a set of eventualities. *Noch/still* is adjoined to that, and below tense. English tells us that
the aspect is imperfective. The AspP hence has the denotation in (9). (For ease of exposition, the
analysis is presented for English where it is not specifically concerned with German.)

(8) $[_{TP} \text{PRES} [\lambda t[\phi [\text{still}_< t^* t] [_{AspP} \text{ipf} [_{VP} \lambda e \text{ rain } e]]]]$

(9) $[[\text{AspP}]] = \quad \lambda t.\exists e[t \subseteq \tau(e) \,\&\, \text{rain}(e)]$
        time intervals included in the run time of a rain event

In order to simplify the composition, let us suppose that the present tense is referential, referring
to t_{now} (see e.g. Kratzer (1998) for such an analysis of tense). We can then consider a simplified
structure (skipping the variable binding in (8)) as in (10), where *noch/still*'s second argument is
t_{now}. The interpretation of this structure, applying *noch/still* to (9), is given in (11). As desired, it
says that a period of rain began before now and continues into the present.

(10)   Assume that PRES is simply t_{now}. Simplified structure:
         [ϕ [still$_<$ t* t_{now}] [$_{AspP}$ ipf [$_{VP}$ λe rain e]]]

(11)   [[(10)]] is only defined if t*∝ t_{now} & ∃e[t*⊆τ(e) & rain(e)]]
         i.e. (10) presupposes that there was rain at a time immediately before now. Then:
         [[(10)]] = 1 iff ∃e[t_{now} ⊆τ(e) & rain(e)]
         i.e. (10) asserts that it is raining.

This is the interpretation standardly associated with this type of example. Let us examine some aspects of it in more detail. First, it is uncontroversial that *noch/still* adds a presupposition about an earlier time. (12a) and (12b) both presuppose that it rained earlier. Notice that I have left the earlier time, *noch/still*'s first argument, as a free temporal variable in (10). The motivation for this comes from data like (13) (constructed after examples in Heim (1990); see also Ippolito (2007)).

(12)   a.   Is it still raining?
         b.   If it is still raining, we should take an umbrella.

(13)   John was cooking yesterday at 6pm. He is still cooking now.

We intuitively take (13) to talk about one long cooking event, i.e. the 6pm cooking is continued. If the presupposition were existential, there would be no reason to do so - John could have stopped and resumed cooking an hour ago. But if the presupposition is about a particular salient time, and the only time mentioned is yesterday 6pm, there must be continuous cooking. Let's next examine the example in more detail:

(14)   a.   [still$_<$ t* t][ipf [λe John cook e]]
         b.   [[(14a)]] is only defined if t*∝ t_{now} & ∃e[t*⊆τ(e) & cook(e)(J)]]
                Then: [[(14a)]] = 1 iff ∃e[t_{now} ⊆τ(e) & cook(e)(J)]

If t* were the time actually mentioned - 6pm, i.e. some interval surrounding 6pm -, then t* wouldn't plausibly be abutting now. I am going to assume that by virtue of mentioning 6pm, the interval from 6pm to now becomes salient, and this is the value for t*.[1]

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[1] Alternatively, we could change the lexical entry for *noch/still* thus:
        (i)   [[*noch/still$_<$*]] = λt*.λt.λP$_{<i,t>}$: P([t*,t)).P(t)
That is, the interval including the salient earlier time up to t is a P interval. I go with the presentationally simpler version in the text, which also provides a clearer connection to marginal uses of *noch/still*. Thanks to Ede Zimmermann, Michela Ippolito and Irene Heim for discussion of this point.

The two examples analysed above happened to be present tense, where we took the argument to be simply t_{now}. More generally, I am going to follow Klein (2007/2015) in taking the argument to be the topic time t_{topic}. In a past tense sentence, this is going to be a past time.

Next, let's turn to the third meaning component of (4). The sentence may give rise to an implicature about the future, i.e. that it may/will stop raining. I suggest that *noch/still*'s argument t introduces alternatives; the time variable is the trigger that creates the alternative set. In the example, they are the ones in (15a). Since presupposition and assertion combine to ensure that it has rained in the past and is raining now, the pragmatically open alternatives concern the future, as indicated in (15b). (All this plausibly concerns some contextually restricted time span, for example this afternoon. I will not make this explicit in the representation.)

(15)   Scalar alternatives:
        a. $[[\phi]]_{Alt} = \{\exists e[t'\subseteq\tau(e) \& rain(e)] \mid t'\in Alt(t)\}$ (Alt-trigger: time variable)
                "when is it raining?"
        b. $\{\exists e[t'\subseteq\tau(e) \& rain(e)] \mid t_{now} <t' \}$ (pragm. 'open' alternatives)
                "when after now is it raining?"

I further suggest that there are appropriateness constraints on alternative sets. This is most easily seen in the case of questions. The question in (16a) is only appropriate if both true and false answers are possible; i.e. (16b) is odd. More generally, the relevant condition is as in (17).

(16)   a.   Who passed?
        b. #   I know that either everyone passed or everyone failed. Who passed?

(17)   Appropriateness condition on the use of a question:
        Let Q <s,<<s,t>,t>> be a Hamblin question intension. Q is only appropriate in w
        if $\exists w'[R(w,w') \& \exists p[Q(w)(p) \& p(w')]] \& \exists w'[R(w,w') \& \exists p[Q(w)(p) \& \neg p(w')]]$
        'It is possible that there is a true answer and it is possible that there is a false answer.'

There is some discussion of presuppositions of questions in the literature, though not exactly (17) as far as I know. Truckenbrodt (2013) discusses the PSP that there is a true answer to the question. Relatedly, Abusch (2002) discusses a PSP on focus-triggered alternative sets that some element of the set of alternatives is true. The difference is that (17) is modalized and concerns both true and false alternatives. My idea here is that this appropriateness condition applies to alternative sets in general, in particular the set of alternatives triggered by *noch/still*. The result is a weak PSP regarding future times. Applied to (4) this yields (18):

(18)   It is possible that there is a time after now at which it is raining &
        it is possible there is a time after now at which it is not raining.
        'It might stop raining.'

This accounts for the oddness of sentences like (19), which has been observed in the literature. Intuitively, there has to be a question regarding future developments for the appropriate use of *noch/still*. The oddness of (19) is precisely because it suggests that John's deadness might change in the future. This means that *noch/still*'s interpretive impact is not limited to meaning components (i) and (ii) about the present and the past.

(19) ? John is still dead.   .
        'John is dead and he's been dead for some time.'   (i) + (ii)
        'What later times is he dead?'   (iii)

(19) shows that there is an obligatory meaning component regarding future times. However, many examples with *noch/still* give rise to a stronger expectation about the future. In our example, this is the possible implicature that it will stop raining. I propose to analyse this as a scalar implicature. I implement this proposal in terms of a covert operator EXH defined (in a simplified version) in (20). According to recent analyses, this operator can be adjoined in the LF. Our example thus optionally has the LF in (21a) in addition to the one in (10). (21b) is the scalar implicature that is generated by this LF.

(20) $[[\text{EXH } \phi]] = 1$ iff $[[\phi]]=1$ & $\forall q[q \in [[\phi]]_{\text{Alt}}$ & $\neg([[\phi]] \Rightarrow q)$ -> $\neg q]$
        "all alternatives that are not entailed are false."
        (see e.g. Krifka (1995), Chierchia, Fox & Spector (2011))

(21)   a. $[\text{EXH } [\phi [\text{noch}_< t^* t_{\text{now}}] [_{\text{AspP}} \text{ipf } [_{\text{VP}} \lambda e \text{ rain } e]]]]$
        b. $\forall q[q \in \{\exists e[t'\subseteq\tau(e) \& \text{rain}(e)] | t'\in\text{Alt}(t_{\text{now}}) \}$ & $\neg([[\phi]] \Rightarrow q)$ -> $\neg q]$
              = $\forall t'[t_{\text{now}} <t' -> \neg\exists e[t' \subseteq\tau(e) \& \text{rain}(e)]]$
              "it doesn't rain after now./It will stop raining."

Generally speaking, this proposal results in possible implicatures $\neg P(t')$ ($t'> t_{\text{now}}$). The relevant meaning component should be analysed as an implicature because it does not always arise, and it is cancellable:

(22) a. It is still raining, and it looks like it will continue to rain.   (cancellable)
     b. Es   regnet immer   noch.   (no scalar impl.)
         it   rains   always   still
         'It is raining STILL.'

This concludes the analysis of the most basic type of use of *noch/still*. Before we turn to structurally more complex data, we take a look at examples in which the predicate in the *noch/still* sentence is naturally part of an ordered sequence. Then, a somewhat richer interpretation can arise. (23) illustrates.

(23) a. Es ist noch Vormittag (Sommer,...)
         It is still morning (summer,...)
     b. % It is still 8am.   (Ippolito (2007))

There is an entailment relation between the predicate in the sentence and other predicates, and such examples invite entailments about 'later' predicates, e.g. afternoon, autumn. Expectedly, this could be implicatures like 'it will be afternoon/autumn later'. Maybe less expectedly, e.g. (23a) may convey that it is not afternoon/autumn yet - i.e. that it is, perhaps, earlier than expected. How does this effect come about? The analysis from above is applied to (23a) below:

(24) a. $[\phi \ [\text{still}_< \ t^* \ t_{now}] \ [\lambda t \ [\text{morning}(t)]]$
         (i)   Assertion: $\text{morning}(t_{now})$
         (ii)   PSP: $t^* \propto t_{now}$ & $\text{morning}(t^*)$
         (iii) Alternatives: $\{\text{morning}(t') \mid t' \in \text{Alt}(t_{now})\}$
     b. $[\text{EXH} \ [\phi \ [\text{still}_< \ t^* \ t_{now}] \ [\lambda t \ [\text{morning}(t)]]]$
         Scalar implicature: $\forall t'[t_{now} < t' \to \neg\text{morning}(t')]$
                              times after t_{now} are not in the morning.
         inference: times after t_{now} are in the afternoon.

So far, nothing in this analysis introduces a meaning component that it is earlier than expected. Now, focus can be added to the picture. Focus on *morning* suggests a contrast with *afternoon*, and this seems to be responsible for the 'early' intuition. Below, I add a Roothian (Roth (1992)) focus semantics to the analysis. Focus is evaluated by the operator ~. The operator comes with the focus anaphor C, which has to pick up a value from the context. The ~ constrains this value to alternative semantic values of its sister. The rest of the interpretation is the same as in (24) above. Suppose that the value of C is $\{\lambda t.\text{afternoon}(t)\}$. The value of C, the focus anaphor, has to be given in the context. Thus (25) would be appropriate in a context in which the proposition that it is afternoon is around. Focus is interpreted as contrast and the alternative is rejected. Thus contrast can account for the intuition that (25) may convey that it is earlier than expected.

(25)   It is still morning_F.   'early'

(26)   a.   [EXH [φ [still$_<$ t* t$_{now}$] [~C [ψ λt [morning_F(t)]]]]]
        b. $[[ψ]]_o = λt.morning(t)$
                  $[[ψ]]_{Alt} = \{ λt.morning(t), λt.afternoon(t) \}$

More generally, if the predicate P in a *noch*-sentence is a member of a sequence, the implicature that the predicate is not true of later times (¬P(t')) allows the inference that a 'later' predicate applies instead (e.g. summer - fall; morning - afternoon - P'(t'); cf. Krifka's (2000)). A suggestion of earlyness may arise if the predicate is focused: focus can create a contrast to a 'later' predicate (e.g. it is not yet afternoon - ¬P'(t$_{now}$)), which is around as an alternative (e.g. expected,...). This is different with predicates like 'rain' which are not ordered by entailment. I conclude that the 'earlyness' effect is circumstantial. Nothing new needs to be said about *noch/still*. We notice, however, that the interpretation of sentences with *noch/still* is affected by focus.

3. Subconstituent readings

3.1. Basic analysis: particle modifies adjunct

We are now prepared for the following type of example, which involves a new structural factor:

(27)   Lydia ist   noch   am Vormittag   abgereist.
        Lydia is   still   in the morning   left
    % 'Lydia left still in the morning.'

In such sentences, *noch* modifies the temporal adverbial PP. In (28) I apply a standard constituency test for German, movement to the prefield (see e.g. von Stechow/Sternefeld 1988). The relevant reading of (27) emerges in (28a), when the *noch*-modified PP is moved to the prefield. When *noch* alone is moved, the resulting sentence only has the slightly odd interpretation that it is still true that Lydia left in the morning. This is the same interpretation as (28c) without the temporal PP.

(28)   a.   Noch   am Vormittag   ist   Lydia abgereist.
                 still   in the morning   is   Lydia left
                 'It was still morning when Lydia left.'
        b.   # Noch   ist   Lydia am Vormittag abgereist.
                 still   is   Lydia in the morning left
              # 'Lydia still left in the morning.'

         c.   # Noch   ist   Lydia abgereist.
                still   is   Lydia left
            # 'Lydia still left.'

The interpretive problem with (28b,c) is easily explained: the predicate *abreisen/leave* does not have a temporal extension, but this is required by the semantics *noch/still*. Hence such 'punctual' verbs or VPs do not straightforwardly combine with temporal *noch/still*. The German sentence (27) is fine under an analysis in which *noch* modifies not the VP but the adverbial PP. Many English speakers do not seem to accept such structures. I call this a subconstituent reading: not the main predicate, but an adjunct is targeted by the particle. (Note that a temporal subconstituent reading is semantically possible only when the adjunct denotes a property of times, type $<i,t>$.). (29) presents an analysis according to this reasoning:

(29) $[_{TP}$ PAST $[[\lambda t$ $[$still$_<$ t^* t [in the morning]]] $[_{AspP}$ pf $[_{VP}$ Lydia leave]]]]

        $[[AspP]] = \lambda t.\exists e[\tau(e) \subseteq t$ & leave(e)(L)]
        $[[$ in the morning $]] = \lambda t.$ morning (t)
        $[[\lambda t$ $[$still$_<$ t^* t [in the morning]] $]] = \lambda t:t^* \propto t$ & morning(t^*). morning(t)
        $[[[\lambda t$ $[$still$_<$ t^* t [in the morning]]] [AspP pf [VP Lydia leave]]]]] =
                  $\lambda t:t^* \propto t$ & morning(t^*). morning(t) & $\exists e[\tau(e) \subseteq t$ & leave(e)(L)]
        $[[PAST]] = t_{topic}$

        $[[TP]]$ is defined only if $t^* \propto t_{topic}$ & morning(t^*).
        Then, it is true iff morning(t_{topic}) & $\exists e[\tau(e) \subseteq t_{topic}$ & leave(e)(L)]

        alternatives: { morning(t') | t'$\in$Alt(t) }   "What (later) times are in the morning?"

(30)   (i)   Assertion: Lydia left before noon.
      (ii)   PSP: a relevant earlier time is also before noon.   (weak)
      (iii)   scalar implicature (local): later times are not before noon.   (weak)

I think that this is a plausible analysis of the example. But I think that here, too, additional interpretive components may arise in interaction with focus. I will consider two possible focus related effects. First, focus on the temporal adverbial can be evaluated as contrast, similar to (25). Second, focus alternatives may play a role in the implicatures that *noch*-sentences give rise to.

3.2. Contrast focus on adverbial

(31) with focus on the adverbial is a plausible example for the first kind of effect - let's call it the contrast interpretation of *noch*-Adv ("~>" indicates an implicature or inference plausibly arising from an example). A contrast analysis is presented below. The ~ operator evaluates focus on *morning*, (32a). Its accompanying focus anaphor C needs to get its value from the alternative semantic value of the sentence, (32b). Let us zoom in on 'Lydia left in the afternoon' as the relevant alternative. A plausible way to interpret this focus is as contrast: the alternative is not true. The sentence asserts that Lydia left in the morning, so a context-available alternative like 'Lydia left in the afternoon' is rejected. But for this alternative to be available means it has to be around, e.g. expected. Possibly, though not necessarily, the overall interpretation is that Lydia left earlier than expected.[2]

(31) Noch   am Vormittag$_F$ ist   Lydia abgereist
      still   in the morning   is   Lydia left
      'Lydia left still in the morning.'
      ~> Lydia didn't leave in the afternoon.

(32) a.   [~C [ϕ [still$_<$ t* t$_{topic}$ [in the morning$_F$]] [[$_{AspP}$ pf Lydia leave]]]]
      b. $[[\phi]]_o$ is as before.
              $[[\phi]]_{Alt}$ = {$\exists e[\tau(e) \subseteq t_{topic}$ & leave(e)(L)]& Q(t$_{topic}$) | Q $\in$ Alt(morning)}
      c.   g(C) = {$\exists e[\tau(e) \subseteq t_{topic}$ & leave(e)(L)]& afternoon(t$_{topic}$)}
              contrast: $\neg(\exists e[\tau(e) \subseteq t_{topic}$ & leave(e)(L)]& afternoon(t$_{topic}$))
              asserted: $\exists e[\tau(e) \subseteq t_{topic}$ & leave(e)(L)]
              ~> Lydia's leaving wasn't in the afternoon.

The type of interpretation that will arise from this combination of ingredients is sketched more generally in (33). This is a plausible interpretation of *noch*-sentences in particular with predicates that occur just once (in the relevant time frame). (34) provides another example.

(33) contrast interpretation of *noch*-Adv:
      a.   [~C [ϕ [still$_<$ t* t Adv$_F$] P]]
      b.   contrast: $\neg$(P(t$_{topic}$) & Q(t$_{topic}$))
              assertion: P(t$_{topic}$) & Adv(t$_{topic}$)
              inference: $\neg$Q(t$_{topic}$) "It wasn't in Q that P occured"

---

[2] If scalar implicatures are calculated at the level of the PP, as hinted at in (30), then the EXH operator responsible for creating those has to be able to pass on alternatives to higher alternative evaluating operators like the ~ in (32). See also Fn. 4.

(34) Lydia kam   noch   am 27.   zur Welt.
     Lydia came   still   on the 27th   to the world
 %   'Lydia was born still on the 27th.'
     ~> Lydia wasn't born on the 28th.

3.3. Exhaustive interpretations of Adv

Let's next consider a good example for the second way focus may affect the interpretation of *noch*-sentences, (35):

(35) Noch 1967$_F$ schlossen   die Kneipen   in Neuseeland   um 18 Uhr.
     still 1967   closed   the pubs   in New Zealand   at 6pm
     'In 1967, closing time for pubs in NZ was still 6pm.'
     ~> after 1967, pubs in NZ didn't close at 6pm.

I will call this type of interpretation an exhaustive interpretation of *noch*-Adv. There is no suggestion that 1967 is unexpectedly early for a 6pm closing time. The sentence may implicate that after 1967, pubs did not close at 6pm. Thus we see a different interpretive effect of focus on the time adverbial: We need to consider the possibility that the alternatives triggered by focus may feature in the scalar implicatures. Below is an analysis to this effect, which generates the desired implicature.

(36) [[still$_<$ t* t$_{topic}$ 1967$_F$] [pubs close at 6pm]]
     (i)   Assertion: ≤1967(t$_{topic}$) & pubs_close_at_6pm(t$_{topic}$)
                           Pubs closed at 6pm in 1967.
     (ii)   PSP: t*∝t$_{topic}$ & ≤1967(t*)
                           A relevant earlier time is no later than 1967.
     (iii) Alternatives: { pubs_close_6pm(t') & Q(t') | t'∈Alt(t$_{topic}$) & Q∈Alt(1967)}
                           'In what later years did pubs close at 6pm?'

(37) [EXH [[still$_<$ t* t t$_{topic}$ 1967$_F$] [pubs close at 6pm]]]
     ∀t'[t$_{topic}$ <t' & 1968ff(t') -> ¬ pubs_close_6pm (t')]
     possible implicature: Pubs didn't close at 6pm after 1967.

(38) ////////// ≤1967 ////////// ‖ \\\\\\\\\\ 1968ff \\\\\\\\\
     -------- t*--------t$_{topic}$------------------------------------->
                                              t'

In this analysis, the focus-triggered alternatives are part of the alternative set for the scalar implicature and negated by the EXH associated with *noch*. *Noch*'s scalar alternatives are evaluated together with the focus alternatives at sentence level; they are not evaluated at the adjunction site of *noch*. This gets us the desired implicature. (39a) and (39b) represent attempts to not figure in focus alternatives; both are too weak to give us the desired implicature.

(39) a. *noch*-alternatives only, local evaluation:
          $\forall t'[t_{topic} <t' \to \neg(1967(t'))]$
          'Later times are not in 1967'
      b. *noch*-alternatives only, sentential evaluation:
          $\forall t'[t_{topic} <t' \to \neg(1967(t') \, \& \, \text{pubs\_close\_6pm}(t'))]$
          'Later times are either not in 1967 or not 6pm-closing times.'

(40) is the general schema for this type of interpretation. I suggest that this is generally possible. *Noch*-sentences with predicates that occur more than once (in the relevant time frame) or are ongoing bring out this interpretation.

(40) exhaustive interpretation of *noch*-Adv:
      a. [EXH [ϕ [still$_<$ t* t Adv$_F$] P]]
      b. assertion: $P(t_{topic}) \, \& \, Adv(t_{topic})$
          implicature: $\forall t'[t_{topic} <t' \, \& \, Q(t') \to \neg P(t')]$
                          'In later time periods, not P.'

(41) Noch am 27. Dezember   haben wir   draussen   gefrühstückt.
      still on the 27th december have   we   outside   breakfasted
      'We still had breakfast outside on December 27.'
      ~> We didn't have breakfast outside after December 27.

The above discussion relates to Löbner's (1990) observation that the interpretation of *noch*-sentences is affected by the presence of a temporal adverbial, by focus and by properties of the predicate. But I utilize syntax and independent mechanisms of alternative evaluation to analyse these effects.

4. Further-to readings of *noch*

4.1. A closer look at the data

Let us first develop a clearer understanding of what happens in the uses of *noch* that Klein calls further-to uses. Example (42), in addition to the continuative reading (he has been showering for some time), has a non-continuative reading that is hard to translate well into English.

(42)   Er   duscht   **noch**.   (further-to)
        he   showers   still
        'He is taking a shower (**before** doing something else).'

The sentence on such a non-continuative reading can be used in two slightly different circumstances, (43). In (44), (45) I provide plausible contexts for the intended interpretations.

(43)   a.   Er   duscht   noch   heute.
              he   showers   still   today.
              (Er   duscht   nicht   erst   morgen.)   (not P later)
              (He   showers   not   only   tomorrow.)
              'He is going to take a shower tonight rather than waiting until tomorrow.'
        b.   Er   duscht   noch   eben. (Dann kommt er.)   (not P' now)
              he   showers   still   just. (Then comes he.)
              'He will take a shower quickly before joining us.'

(44)   context for 'not P later':
        Thilo and I have just come home from climbing. It is very late.
        Thilo: Duschst   Du   noch?
               shower   you   still
               'Are you going to take a shower before you go to bed?'
        Sigrid: Auf   jeden   Fall.
                in   any   case / 'absolutely'.
                'I am taking a shower now. I am not going to wait until tomorrow morning.'

(45)   context for 'not P' now':
        We have guests. I have just come home from soccer practice. It is fairly late.
        Sigrid: Ich   dusch noch. Dann gibt's   Abendessen.
                I   shower still. Then there is   dinner
                'I am just taking a quick shower. Dinner will be just after.'
                'We will have dinner in a little while rather than right now.'

These examples have a weak PSP. The interpretive effect of *noch* seems to concern mostly the future; it can be described as 'before something else happens'. The literature (Umbach (2009), Klein (2007/15)) observes that for this type of example, there is an interesting interaction with focus. To see this, we consider syntactically more complex predicates like (46). Depending on focus, the sentence has the readings in the English translations. I return to this in section 5.

(46) Bruckner hat noch   drei   Bier   getrunken.   (Klein)
      Bruckner has still   three beer   drunk
      'Bruckner had (**another/also/then**) three glasses of beer.'

For the further-to reading, I only know of one analysis: Klein (2007/15). His proposal (translated into the general framework used here) is sketched in (47).

(47)   [[noch]] = $\lambda t^*.\lambda t.\lambda x.\lambda P_{<x,t>}: t^* \propto t$ & **P'**$(x)(t^*)].P(x)(t)$
                     possible 'future' propositions: $\{P(x)(t') \mid t'>t\}$

Note that Klein divides the sentence into topic and a predicate attributed to the topic (x and P above). I do not follow him in this. But even apart from that, (47) is not compatible with the structural compositional analysis of *noch* 'still': I have assumed throughout that the predicate in the presupposition is the same as the predicate in the assertion. The weak presupposition in further-to readings hence has to have a different source.

4.2. Proposal: subconstituent reading with silent adverbial

How can the analysis of *noch/still* from the preceding sections be extended to further-to *noch*? I propose that the further-to reading is a temporal subconstituent reading, along the lines of section 3. Subconstituent readings, remember, lead to weak presuppositions. This is going to account for the fact that the meaning component concerning earlier times is weak in the further-to examples. It is not immediately obvious that we are dealing with a subconstituent reading because the subconstituent in question may be phonologically empty. Empty or overt, it is a temporal adverbial with a meaning amounting to 'now', 'just'. I spell out this idea first for an example with overt 'now', 'just'. I then extend it to covert occurences of the time adverbial.
Let's first see an analysis of an example with an overt temporal adverbial 'now' as in (48a,b). (48a) can be used in the context in (49). It conveys on the relevant reading that Thilo will prune the tree before we go on holiday - now - rather than later. The analysis developed above predicts this. We assume the structure in (50) where *noch* modifies *now*. The interpretation is (51).

(48) a.   Thilo schneidet   jetzt   noch   den   Apfelbaum.
              Thilo prunes   now   still the   apple tree
              'Thilo will prune the apple tree now.'
              ~> Thilo won't prune the apple tree later.
      b.   Ich   gehe   noch   eben   einkaufen.
              I   go   still just   shopping
              'I will go shopping quickly.'
              ~> I won't join you just yet.

(49) context: We go on holiday for two weeks on March 11. Apple trees have to
                     be pruned in the early spring, i.e. before March 15.

(50) [[noch t* t_{topic} now]] [λt[Thilo prune the apple tree at t]]]

(51) (i)   Assertion: Thilo prunes the apple tree at t_{topic} and now(t_{topic})
      (ii)   PSP: t*< t_{topic} and now(t*)
      (iii)   alternatives: {now(t') | t'> t_{topic} }
                             possible implicature: later times are not in 'now'.

A plausible interpretation is as a contrast interpretation of *noch*-Adv. This implies that the alternative is rejected, i.e. Thilo doesn't prune the apple tree later.

(52) [~C [[noch t* t_{topic} now_F]] [λt[Thilo prune the apple tree at t]]]]

      g(C) = {that Thilo prunes the apple tree later}

Note that the example is parallel to the 'Lydia left still in the morning' example. The example is appropriate if 'now' is contrasted with 'later', which is given in the context. We divide the time scale into 'now' vs. 'later' as indicated in (53).

(53) /////////////now///////// || \\\\\\\\later\\\\\\\\\
      ------- t*-------- t_{topic} ----------------------------------->
                                          t'

Let us now return to the shower example. The further-to examples from above have the same meaning with or without a time adverbial denoting the topic time, for example (54a) and (54b) are identical in meaning. Both have the two subtly different interpretations described in (55).

(54) a.   Er   duscht   noch   eben.
            he   showers   still   just
            'He is just taking a shower.'
      b.   Er   duscht   noch.
            he   showers   still
            'He is just taking a shower.'

(55) a.   He is taking a shower now rather than taking a shower later.
            (e.g. in the morning).   (not P later)
      b.   He is taking a shower now rather than
            e.g. coming immediately to the meeting.   (not P' now)

I propose the analysis in (56) - (58). *Noch* modifies an overt or covert time adverbial, where I write the covert version as <now>.

(56) a.   covert <now>, *eben* 'now', 'just':
            a short period of time overlaping with the topic time t_{topic}.
      b. $[[<now>]] = \lambda t.now(t)$

(57) [[noch t* t_{topic} <now>]] [λt[he take a shower at t]]]

(58) (i)   Assertion: He takes a shower at t_{topic} & now(t_{topic})
      (ii)   PSP: t*< t_{topic} and now(t*)   (weak)
      (iii)   alternatives: {now(t') | t'> t_{topic} }
                             possible implicature: later times do not fall within 'now'.

One interpretive effect of adding the scalar particle is the division of the relevant time period into 'now' vs. 'later'. Another interesting aspect of the interpretation concerns the alternatives. If in the alternatives the time adverbial varies, we get the first type of interpretation 'not P later'. This is parallel to the apple tree example, a contrast interpretation of *noch*-Adv. Alternatively, an interpretation can arise from contrast in the predicate: he doesn't come to the meeting now.

(59) [~C [[noch t* t_{topic} <now>]] [λt[he take a shower at t]]]]

(60) a.   interpretation 'not P later' - analysis:
            g(C): {he take a shower Q |Q$\in$Alt(now)}
            contrast: he doesn't take a shower later, e.g. in the morning.

b.   interpretation 'not P' now' - analysis:

g(C):   {he Q now | Q∈Alt(take a shower)}

contrast: he doesn't come to the meeting now (he might come later).

c.   both interpretations: something else happens after t_{topic} ('before...')

The idea is applied to (48b), with overt or covert 'now', 'just'. Focus on the predicate leads to a plausible 'not P' now' interpretation via contrast.

(61)   a.   Ich   geh   noch   (eben) einkaufen.

I   go   still   (just) shopping

'I will quickly go shopping (before ...).'

b.   [[noch t* t_{topic} <now>]] [λt[I go shopping at t]]]

c.   Assertion: I go shopping now.

PSP: t*< t_{topic} and now(t*)

possible implicature: $\forall t'[t_{topic} <t' \rightarrow \neg now(t')]$

'Later times do not fall within 'now'.

d.   [~C [[EXH [noch t* t_{topic} <now>]]] [λt[I go shopping at t]]]]

contrast: {I Q now | Q∈Alt(go shopping)}

e.g. I'm not done with my chores just yet, but after shopping I will be.

In any case, the temporal perspective added by *noch/still* divides the series of activities into the ones that happen 'now' vs. the ones that happen 'later', as noted in Klein (2007/2015). This is the main contribution of the particle.[3]

5. Focus effects and further-to *noch*

Next, let's take a more careful look at the role of focus in the syntactically more complex cases, cf. Klein's example below. Different information structures are appropriate in different contexts.

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[3] The further-to examples in this section have so far all been analysed as contrast. Note that an exhaustive interpretation of *noch*-Adv with 'now' as the Adv (analogous to the 1967 example) is not readily distinguishable from a regular continuous interpretation with scalar implicature:

(i)   a.   (jetzt) noch schliessen die Kneipen um 18:00.

(now) still close the pubs at 6pm

'Pubs still close at 6pm.'

b.   [EXH [[still t* t_{now} <now>$_F$] [pubs close at 6pm]]

{pubs_close_6pm(t') & Q(t') | t'∈Alt(t_{now}) & Q∈Alt(now)}

$\forall t'[t_{now}<t' \rightarrow \forall Q[Q \neq now \rightarrow \neg pubs\_close\_6pm(t') \& Q(t')]]$

c. $\forall t'[t_{now}<t' \rightarrow \neg pubs\_close\_6pm(t')]$

Hence we have not seen a clear example of an exhaustive interpretation of *noch*-Adv (akin to the 1967 example) in this section. But see the Bruckner examples below for plausible candidates.

(62)   Bruckner hat   noch   drei   Bier   getrunken.   (Klein 2007/2015)
         Bruckner has   still   three beer   drunk
         'Bruckner had (another/also/then) three glasses of beer.'

     a.   Bruckner hat   einen   Germknödel   gegessen.
            Bruckner has   a   dumpling   eaten
            'Bruckner first ate a dumpling.'
            Dann   hat   er   noch   drei   BIER   getrunken.
            Then   has   he   still   three   BEER   drunk.
            'Then he had three glasses of beer.'
     b.   Bruckner hat   einen   Schnaps   getrunken.
            Bruckner has   a   schnaps   drunk
            'Bruckner drank a schnaps.'
            Dann   hat   er   noch   drei   BIER   getrunken.
            Then   has   he   still   three   BEER   drunk.
            'Then he drank three glasses of beer.'
     c.   Bruckner hat   drei   Bier   ausgeschüttet.
            Bruckner has   three beer   spilled
            'Bruckner spilled three glasses of beer.'
            Dann   hat   er   noch   drei   Bier   geTRUNken.
            Then   has   he   still   three   beer   DRUNK.
            'Then he drank three glasses of beer.'
     d.   Bruckner hat   drei   Bier   getrunken.
            Bruckner had   three beer   drunk
            'Bruckner drank three glasses of beer.'
            Dann   hat   er   NOCH   drei   Bier   getrunken.
            Then   has   he   STILL   three   beer   drunk
            'Then he had another three glasses of beer.'

Let's begin with an analysis of (62a). The structure we interpret is (63), i.e. this is a further-to reading with a covert <now>. There is a weak *noch* PSP that some relevant earlier time t* falls into now. There is also a PSP triggered by focus that Bruckner did something else. Since no further context is given, it is natural to assume that this something else happened at the relevant earlier time t*. The combined effect is a PSP that Bruckner did something alternative to drinking beer earlier. This explains that the sentence is appropriate in a discourse context like (62a).

(63)   [noch t* t$_{topic}$ <now>] [Bruckner [drei Bier trinkt]$_F$] ~C

PSP *noch*: t*< t$_{topic}$ and now(t*)
PSP focus: g(C) = that Bruckner Q at t" : Q ∈Alt(drink three beers) & t"∈Alt(t$_{topic}$)
inference: t" =t* and g(C) is entailed (focus antecedent is entailed, not just
                given)
                =>   Bruckner Q at t* & now(t*): Q ∈Alt(drink three beers)
                        "Bruckner did something else (like eating a G.) earlier."

(64) and (65) are parallel analyses of (62b) and (62c). We simply combine the analysis of *noch* and the analysis of focus to get the desired interpretation. Proceeding in a parallel way with the example with stressed *noch* yields an interesting effect. Since the rest of the clause is deaccented, it has to be given. This leads to an additive sentence interpretation. The general idea is that focus, as always, is anaphoric. In the above analysis, this is independent of *noch*. The overall interpretation arises from the combined effects of *noch* and focus.

(64)   [noch t* t$_{topic}$ <now>] [Bruckner [drei Bier]$_F$ trinkt] ~C

PSP *noch*: t*< t$_{topic}$ and now(t*)
PSP focus: g(C) = that Bruckner drinks x at t" : x ∈Alt(three beers) & t"∈Alt(t$_{topic}$)
inference: t" =t* and g(C) is entailed
                =>   Bruckner drank x at t* & now(t*): x ∈Alt(three beers)
                        "Bruckner drank something else (e.g. a schnaps) earlier."

(65)   [noch t* t$_{topic}$ <now>] [Bruckner drei Bier [trinkt]$_F$] ~C

PSP *noch*: t*< t$_{topic}$ and now(t*)
PSP focus: g(C) = that Bruckner R three beers at t" : R ∈Alt(drink) & t"∈Alt(t$_{topic}$)
inference: t" =t* and g(C) is entailed
                =>   Bruckner R three beers at t* & now(t*): R ∈Alt(drink)
                        "Bruckner did something else with 3 beers (e.g. spill) earlier."

(66)   [NOCH t* t$_{topic}$ <now>] [Bruckner drei Bier trinkt] ~C

PSP *noch*: t*< t$_{topic}$ and now(t*)
PSP focus: g(C) = that Bruckner drink three beers at t" : t"∈Alt(t$_{topic}$)
inference: t" =t* and g(C) is entailed
                =>   Bruckner drink three beers at t* & now(t*)
                        "Bruckner drank 3 beers earlier."

Let's also take a look at the implicatures of these sentences. Intuitively, the alternatives are: when will Bruckner stop consuming things (drinking, doing things to beer, ...) ("now") and move on to some new activity ("later") ((67a,b) for (62b,c))? Constructing scalar implicatures from these sets will lead to implicatures given in (68) and illustrated by the expected continuations:

(67) a. {Bruckner drink x at t' & Q(t') | t'> t_{topic} & Q∈Alt(now) & x∈Alt(3 beer)}
      b. {Bruckner R three beers at t' & Q(t') | t'> t_{topic} & Q∈Alt(now) & R∈Alt(drink)}

(68) a. ∀t',Q,x[t_{topic}<t' & Q∈Alt(now) & x∈Alt(3 beer)->
              ¬[Bruckner drink x at t' & Q(t')]]
          '... Then, Bruckner stopped drinking.'

      b. ∀t',R,x[t_{topic}<t' & Q∈Alt(now) & R∈Alt(drink)->
              ¬[Bruckner Red 3beer at t' & Q(t')]]
          '... Then, Bruckner stopped doing things to beer.'

These implicatures can be derived with EXH as before.[4] LFs including EXH for the two examples are given below. They yield 'not P' later' interpretations where P' is defined by focus alternatives. These examples are exhaustive interpretations of *noch*-Adv with an added focus in the predicate (similar to the 1967 example in section 3). Just as before, part of the interpretive effect is to divide the time period under consideration into 'now' and 'later'.

(69) a. [[noch t* t_{topic} <now>] [Bruckner [drei Bier]$_F$ trinkt] EXH] ~C
      b. [[noch t* t_{topic} <now>] [Bruckner drei Bier [trinkt]$_F$] EXH] ~C

This analysis of further-to *noch* looks plausible enough to me, with one remaining issue: I believe that for additive *noch*, the analysis in (66) has the wrong constituency. The additive reading is one in which *noch* forms a constituent with the NP, as (70) below shows. This means that the structure in (66) is at least not the only possibility for an additive sentence interpretation. See Umbach (2009) for a proposal.

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[4] The analysis will work out the way described if EXH passes on focus alternatives, so that the ~ can access them:

(i) $[[EXH \phi]]_o$ = 1 iff $[[\phi]]$=1 & ∀q[q ∈$[[\phi]]_{Alt}$ & ¬($[[\phi]]$ ⇒ q) ->¬q]
         $[[EXH \phi]]_{Alt}$ = $[[\phi]]_{Alt}$

This is an interesting aspect of the analysis of an alternative evaluating operator, cf. Beck (2016) for discussion. The same point can be made for more detailed LFs of some earlier examples, e.g. the Lydia example.

(70)   NOCH   drei   Bier   hat   Bruckner getrunken.
       STILL   three   beers   has   Bruckner drunk
       'Bruckner had another three beers.'

6. Conclusions

This paper is part of a larger plot to reduce the various uses of the scalar particles *noch/still* to one underlying semantics. At first glance, this doesn't seem particularly promising for further-to *noch*. My proposal uses the combined effects of syntactic structure, presupposition, implicature and focus to derive a further-to interpretation of the *noch*-sentence on the basis of regular *noch/still*. In addition to deriving the reading of these particular sentences, it highlights a difference between German and English: (un-) availability of adjunction to modifiers. Furthermore, it brings an interesting case of alternative generation to our attention: the time argument of *noch/still*. And finally, the evaluation of focus in *noch*-sentences permits several possibilities, yielding different interpretive effects. This last point draws our attention to the unresolved issue of the focus semantics of the widely used EXH operator.

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The Beginnings of Formal Semantics:
The Historical Context of Arnim von Stechow's Contributions

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1. Introduction

Arnim and I have been colleagues and friends for a long time. I think we first met at Ed Keenan's 1973 conference at Cambridge University, so more than 40 years ago. We've never worked directly together, but we've interacted over the years in various ways, at conferences, with visits, through students like Irene Heim and colleagues like Angelika Kratzer and mutual admired friends like Max Cresswell and David Lewis.

The organizers of the Von Stechow Workshop at Sinn und Bedeutung 20 in 2015, knowing that I'm working on a project on the history of formal semantics and knowing of my long connection with Arnim, suggested that I might give a talk that takes us back in time to the beginnings of formal semantics and leads us through some of the great achievements, milestones, and the 20 years of Sinn und Bedeutung to the present, setting the scene for the three other invited talks that will celebrate Arnim's contributions to the field.

That suggested job was too big, given the exponential growth of achievements and milestones since the beginnings in the late 60's. I have focused on the period from the late 60's until the late 80's, giving very abbreviated accounts of matters I have written about in other papers (Partee, 2011, 2013a, 2013b, 2015), and inserting little bits of Arnim's history at appropriate points.

And afterwards I was invited to turn my talk into a paper for the workshop collection; I am leaving the paper in the informal style of the talk.

2. Semantics before formal semantics

2.1. Semantics in linguistics up to the 1960s

The context in which formal semantics emerged was different on the two sides of the ocean. In talks and papers on the history of formal semantics, I've emphasized the scene in the US into which Montague emerged. But I've been reminded by a number of European colleagues that parts of that context were quite US-specific.

A thumbnail summary of the early history in the US includes negative attitudes to semantics in American linguistics in the 20th century, influenced by logical positivism and behaviorism. There was rather little semantics in early American linguistics, partly for that reason and partly as a result of fieldwork tradition: one starts with phonetics, then phonology, then morphology, then perhaps a little syntax, and usually no semantics beyond dictionaries and structuralist decomposition of important semantic fields like kinship terms. At the same time, there was great progress in semantics in logic and the philosophy of language, but that was largely unknown to

most linguists.

And then my US-centric history continues with emphasis on Chomsky, the Katz-Postal hypothesis that meaning is determined at Deep Structure, and then the Linguistic Wars (Partee, 2014).

Let me just mention here the Bar-Hillel – Chomsky interchange in the 1950's, since Bar-Hillel will return as part of Arnim's history. In 1954, Yehoshua Bar-Hillel wrote an article in Language (Bar-Hillel, 1954) inviting cooperation between linguists and logicians, arguing that advances in both fields would seem to make the time ripe for an attempt to combine forces to work on syntax and semantics together. He was arguing against logicians who considered natural language too unruly to formalize, and appealing to linguists to make use of some of the logicians' methods.

And then in 1955, Chomsky, then a Ph.D. student, wrote a reply (Chomsky, 1955), arguing that the artificial languages invented by logicians were so unlike natural languages that the methods of logicians had no chance of being of any use for linguistic theory. (Chomsky and Bar-Hillel remained friends.)

Bar-Hillel didn't give up, though. In 1967 he wrote to Montague, after receipt of one of Montague's papers: "It will doubtless be a considerable contribution to the field, though I remain perfectly convinced that without taking into account the recent achievements in theoretical linguistics, your contribution will remain one-sided."[1]

Semantics in early European linguistics was mainly lexical; lexical semantics and principles of semantic change and semantic drift were important for historical and comparative linguistics. Structuralism arose first in Europe, and Saussure was influential for structuralism, for putting synchronic grammar into the foreground, and for conceiving of grammar as connecting form and meaning. Bühler's *Sprachtheorie* (Bühler, 1934) included an early treatment of indexicality and perspective-shift.

Jespersen made lasting contributions to semantics as well as syntax (Jespersen, 1924); while in the Netherlands, Evert Beth was laying foundations (Beth, 1947, 1963) for the cooperation among logicians and linguists that made the Netherlands one of the major contributors to the development of formal semantics from the start.

The situation in philosophy and logic had different divisions, not Europe vs the US.

The Frege-Russell-Carnap-Tarski developments, and Polish logic (Łukasiewicz, Ajdukiewicz), cut across continents, given that Carnap and Tarski both emigrated to the US.

The Ordinary Language – Formal Language wars in philosophy of language were largely fought

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[1] From a letter from Bar-Hillel to Montague, 20 Nov 1967 (in the Montague archives, UCLA).

within Anglo-American philosophy.

But as Arnim mentioned to me in discussing his own education, philosophy in Germany was largely dominated by continental philosophy. So whereas philosophers were among the leaders in developing the earliest formal semantics in the US, the Netherlands, New Zealand, and Scandinavia, that was not the case in Germany, where linguists, notably Arnim, had to teach themselves the necessary formal and logical tools and develop formal semantics themselves.

2.2. Philosophy and logic: antecedents to the work of Montague, Lewis, Cresswell, et al.

The foundational work of Frege, Russell, Carnap and Tarski led to a flowering in the middle third of 20th century of work on modal logic, tense logic, conditionals, referential opacity, and other philosophically interesting natural language phenomena. It was in (Wittgenstein, 1922) that we find the first articulation of the idea that "To know the meaning of a sentence is to know what is the case if it is true".

The field was further advanced by Kanger's and Kripke's work (1957a, Kanger, 1957b, Kripke, 1959) distinguishing between possible models of a language (the basis for the semantical definition of entailment) and possible worlds (possible states of affairs) to be included within a given model, giving a model-theoretic semantics for modal notions.

Reichenbach (1947) and then Prior (1967) made great progress on the development of the logic of tenses, and hence on context-dependence; Thomason (1996) identifies Prior as an important contributor to "natural language semantics logicism".

2.3. Pushes towards formal semantics

I mentioned Bar-Hillel's unsuccessful appeal in 1954. At that time, each side was convinced that they had nothing to learn from the other. Frits Staal and Bar-Hillel both kept trying; both had good relations with both Montague and Chomsky.

In the summer of 1967, Staal, Bar-Hillel, and Curry organized a symposium during the 3rd International Congress for Logic, Methodology, and Philosophy of Science, on "The Role of Formal Logic in the Evaluation of Argumentation in Ordinary Language". Bar-Hillel prepared an opening position paper, and participants included Montague, Jerry Katz, Dummett, Geach, Hintikka, and others.

As Staal noted in the edited condensed discussion (Staal, 1969), quite a few people then knew of Montague's work, and quite a few knew about MIT linguistics (represented by Katz), but few knew both.

3. The beginnings of formal semantics – 1966-70

With few exceptions, most of the new work on tense and aspect, modality, opacity, etc., as well as Montague's own work in papers like "Pragmatics and Intensional Logic", followed the tradition of not formalizing the relation between given natural language constructions and their logico-semantic analyses or 'reconstructions': the philosopher-analyst served as a bilingual speaker of both English and the formal language used for analysis.

That changed dramatically in the late 1960's, starting with Montague's "English as a Formal Language" and "Universal Grammar" (Montague, 1970a, Montague, 1970b), David Lewis's "General Semantics" (Lewis, 1970), Terry Parsons' "A Semantics for English" (Parsons, 1968), von Stechow's "Formale Semantik" (Brockhaus and von Stechow, 1971a, 1971b), Cresswell's *Logics and Languages* (Cresswell, 1973).

3.1. Motivations and stimuli for that work

So one might well ask why this big change occurred in the late 1960's and early 1970's. Apart from Arnim, the cited authors are all logicians and philosophers.

In the case of Montague, what I tracked down in the Montague archives and in correspondence with his PhD students Nino Cocchiarella and Hans Kamp is reported in (Partee, 2013a). In a nutshell, it was in part his experience with the Kalish and Montague logic textbook (Kalish and Montague, 1964), where they formulated quite explicit rules for mapping between first-order logic and a regimented subset of English. And I found a statement of his own in his handwritten introduction to an early talk version of "English as a Formal Language", July 31, 1968, UBC, Vancouver, which includes "This work is the result of two annoyances …", which turn out to be (i) the Ordinary Language vs. Formal Language wars in philosophy of language, and (ii) "The great sound and fury that nowadays issues from MIT under the name of "mathematical linguistics" or "the new grammar" – a clamor not, to the best of my knowledge, accompanied by any accomplishments." He wanted to show that ordinary language could be formally analyzed, even if he somewhat denigrated the task as "rather easy and not very important."

As for David Lewis, he appreciated Chomsky, appreciated the issues in the linguistic wars, appreciated Montague and had similar ideas himself (he discussed things with Montague, so some of their ideas may be joint.) His 1970 paper, written for linguists as an invited talk for a syntax conference at UC San Diego, offers a palette of alternatives, and is designed to show linguists how a "real semantics" can be added to generative grammar.

Max Cresswell visited UCLA in 1969-70, and was greatly impressed by Montague's "English as a Formal Language" course, which inspired his own thinking.

Arnim had studied logic and also linguistics. He was very interested in semantics, but not satisfied with what was in (Lyons, 1977), because it had a lot of semantics but no entailment –

just notions like synonymy, hyponymy, hyperonymy, ambiguity, etc.[2]

The mathematician Klaus Brockhaus was Arnim's 'real teacher' in linguistics at the University of Muenster; he worked on machine translation and helped them learn about formal grammar. Arnim wanted to have a more formal kind of semantics; he and Brockhaus worked on that. Their 1971 'Formale Semantik' is in proceedings from a 1970 Regensburg conference; their related 1971 paper in English is in Linguistische Berichte – they are important early documents and are Arnim's first semantics papers[3]. The formal semantics they developed was 'very syntactic' in the sense of all being axiomatic rather than model theoretic; they axiomatized the notions of synonymy, hyponymy, etc.

Arnim at the time "had the idea 'Why we don't have as meanings something you have in the formal languages, truth conditions or truth values, etc.?' and he [Brockhaus] said, 'This is an interesting thought, but it's totally absurd!'". They hadn't heard of Montague – Arnim was inventing it for himself.

3.2 A footnote

About Montague's acquaintance with Chomsky's work: In spring 1966, Montague taught in Amsterdam, and Frits Staal was then leading a workgroup on formal grammar. At a joint group meeting, Staal and Montague compared Chomsky's (*Aspects*) way and Montague's way of dealing with certain sentences. Henk Verkuyl recalls an interesting contrast[4]:

"What Frits did was to take a quite long sentence with adverbials (*on the corner*, if I remember well). Frits took care of the *Aspects* way of dealing with this sentence [with trees]. Montague then presented his own alternative. He did so by climbing on a chair and writing formula after formula on the blackboard -- without too much of an explanation; and so he was generally considered as a somewhat strange sort of person, however kind he seemed to be."

4. Some milestones and issues

1965 – The journal *Foundations of Language* was founded by Frits Staal and colleagues, including Morris Halle, with a call for interdisciplinary cooperation. Its last year was 1976; it was followed by *Linguistics and Philosophy*.

1967-69 -- Davidson and Harman were together at Princeton for those two years, intensely

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[2] These biographical notes about Arnim come from our interview on March 14, 2011, in Oslo.

[3] Brockhaus and von Stechow's 1971 papers are the earliest references I know of to the terms *formal semantics* and *formale Semantik* in linguistics. (The next earliest seems to be Keenan's 1973 conference "Formal Semantics of Natural Language".)

[4] Interview, December 17, 2013, in Amsterdam.

interacting, both optimistic about potential fruitfulness of linguistics-philosophy interactions. They were optimistic about generative semantics. They influenced each other's work; and together they produced some exciting conferences and influential edited collections.

At the same time David Lewis and Montague were both at UCLA, also interacting; David introduced me to Montague and I first sat in on a seminar of Montague's at UCLA (with David and Frank Heny) in 1968. I had a lot of dumb questions at the beginning, and David was the one I could ask them to; he always answered patiently and well. It was also David who urged Max Cresswell in December 1969 to sit in on Montague's winter quarter 1970 course on "English as a Formal Language" – Max says he didn't even know what that meant, but was quite blown away by what he encountered there.

1969 – Davidson & Harman organized a conference of linguists and philosophers at the Center for Advanced Study in the Behavioral Sciences. Generative semantics was well represented. Geach presented "A Programme for Linguistics", countered by McCawley's "A Programme for Logic". At the conference, the philosophers included Quine, Geach, and David Kaplan (and not Montague); the linguists included Bach, Lakoff, McCawley, and Partee. Davidson and Harman published an expanded set of papers in a special edition of Synthèse in 1970, with more authors than were at the conference (e.g. that's where David Lewis's 'General semantics' was first published), then expanded it further into an edited volume (Davidson and Harman, 1972) (adding Kripke's 'Naming and Necessity'). That volume gives a good picture of the state of linguistics-philosophy interaction in the late 1960's, when there was quite a lot of it, but just before Montague began to have a big influence. Davidson and Harman did a great deal to promote linguistics-philosophy interaction, but not formal semantics as we know it.

1966 – The University of Konstanz, conceived in 1965, started that year with a makeshift beginning in a wing of the Inselhotel, formerly a Dominican monastery.

1967 – The start of today's campus of the University of Konstanz was developed through individual construction projects on the hill known as the Gießberg.

1969 (I think): Arnim came to Konstanz from Münster, as one of the original hires, as Assistant Professor. (The full professor hired then was Peter Hartmann.)

Out of order but relevant here - 1973: While at Munich, Irene Heim wrote to Peter Lutzeier (June 1973) for some advice; he replied (July 1973) with a good letter about what he thought about linguistics in departments all over Germany. So in the summer of 1973 Irene looked at some places, fell in love with Konstanz; Lutzeier had also recommended it as an excellent place, because of Arnim.

Fall 1973 Irene remembers a class with Arnim in which they read Schnelle's translation of Montague's "Universal Grammar" (Montague, 1970a).

Spring 1970 - There was a small conference of linguists and philosophers at UCLA, memorable

in part because it was moved to the basement of a church after Reagan closed the University of California in the wake of protests over the bombing of Cambodia. Talks were by philosophers Montague, Julius Moravcsik, John Vickers, and Martin Tweedale, and linguists George and Robin Lakoff, George Bedell, and me; attendees included Bruce Vermazen, Lauri Karttunen, Bob Wall, and then-students Michael Bennett and Larry Horn.

That was the time when I intervened in an argument between Lakoff and Montague about whether it was crazy to derive prenominal adjectives from relative clauses or crazy not to, explaining to each of them where the other's position was coming from, and during the coffee break got the closest to a compliment I ever got from Montague – "Barbara, I think that you are the only linguist who it is not the case that I can't talk to." (Larry Horn, already a budding negation specialist, also noticed that sentence and copied it down; our memories agreed 35 years later.)

Fall 1970 – the Moravcsik, Hintikka and Suppes conference at which Montague presented PTQ; the resulting publication was (Hintikka et al., 1973).

There was more at that conference, but I don't remember much else. When "part 2" was held a few months later, in December, we were all to make comments on as many of the other participants' papers as we wished. I decided to put all my efforts into commenting on Montague's paper. I commented on Montague's syntax, comparing it with transformational grammar (Partee, 1973b). I recall David Kaplan saying that by listening 'inversely', he was able to understand something about how transformational grammars worked. And Montague didn't object to my description of what he was doing – that was reassuring.

I wasn't ready to work with Montague's semantics yet, but I was quite excited about it, and started working on a UCLA research grant proposal to try to work 'with' Montague, sort of. (I planned to pose puzzles and see if I could interest him in trying to solve them.)

March 7, 1971 – Montague's death, at age 40 - a total shock.

Summer 1971 -- Summer School in Semantics and Philosophy of Language at UC Irvine, organized by Donald Davidson and Gil Harman. A life-changing event for some of us. [Montague had been upset when he learned about it – he was not invited.]

There were two 3-week sessions, each with twice-a-week lecture plus discussion session (3 hours) by 3 philosophers and one linguist. Lecturers in the first session were Grice, Davidson, Harman, and me as the linguist; the second session had Strawson, Quine, Kaplan, and Haj Ross as the linguist. And there was a special evening series by Kripke on his just-completed "Naming and Necessity". The "students" were young philosophy professors, including Rich Thomason, Bob Stalnaker, Gareth Evans, Dick Grandy, Peter Unger, Steven Stich, Bill Lycan, Bob Martin, Oswaldo Chateaubriand, Carl Ginet, Sally McConnell-Ginet, James McGilvray, and many others; and many of them gave evening lectures. (And Gil Harman reports "After intense discussions, we would spend time in Laguna Beach, where Davidson was teaching Quine to

surf.")

 (For me that was the summer I finally appreciated what lambdas could do. I saw how one could get rid of Equi-NP-deletion by introducing a Derived VP rule to make open sentences into property-denoting VPs (Partee, 1973a)).

Fall 1971: David Kaplan and I each taught a seminar at Stanford, one afternoon a week, and sat in on each other's seminars – his on demonstratives and mine on Montague grammar. I learned a lot from him, and also got a lot of help from him, Jaakko Hintikka, and Julius Moravcsik as I struggled to understand Montague's intensional logic in my first attempt to explain what he had done and what a linguist could do with it.

1971 – Brockhaus & von Stechow papers, independent of Montague
Also Bar-Hillel spent 1971 sabbatical year at Konstanz – more on this below.

1971 – This year also saw the publication of two papers by the independent Ed Keenan on what may well be called formal semantics: Names, quantifiers, and a solution to the sloppy identity problem (Keenan, 1971a), and Quantifier structures in English (Keenan, 1971b).

1972 – The circulation of the second version of Terry Parsons's big fragment with his combinatorial way of doing formal semantics of English (Parsons, 1972), whose first version had been circulated in 1968 (Parsons, 1968).

1971 – Bar-Hillel spent a year at Konstanz. He read the Brockhaus and von Stechow papers, and as Arnim recalls, "he said he had studied the thing Brockhaus and I had written, and he said it was ingenious and it had gone almost so far as Montague, and I should read that. So then I started reading Montague, and the first thing I read was English as a Formal Language. That I always liked, because I also always had the idea that you have to have sentence meaning as truth conditions somehow. And then the second idea was also that you had to interpret syntax directly, and EFL did that, without [some translation] in between, and that I liked." Let me include a part of our interview here (A = Arnim, B = Barbara):

  A: And later on, the second thing I read then was Universal Grammar. … It's hard, yeah, but that's the one I liked best in some sense.
  B: And you read these by yourself? It's hard!!
  A: Well, we did, … I could ask no one, I had a bit of logical background, but I had to teach myself everything and this was really hard stuff.
  B: Did you know lambdas before?
  A: No, of course not!
  B: Neither did I and it was …
  A: Hard. No, it took me also a long time.
  …
  A: And PTQ came much later, and I never liked it so much.

There were major early contributions to formal semantics in Europe starting in the early 1970's.

Renate Bartsch had come to UCLA to work with Montague just before his death; she and I had fruitful discussions, but much more significant was her collaboration with Theo Vennemann, which began then at UCLA and continued in Germany (Bartsch, 1972, Bartsch and Vennemann, 1972). Arnim von Stechow was an early and influential contributor to the rise of formal semantics in Germany and Europe. A number of formal semanticists in other European countries point to von Stechow as the source of their earliest acquaintance with Montague's work.

In my interviews with them, both Arnim and Angelika told me more about their substantial work on theories of syntax (Kratzer et al., 1974), including context-free grammars with features, transformational grammar, dependency grammar, categorial grammar … So they were never as impressed as some of us were when Gazdar et al's work in the early 1980's plus a rich semantics seemed to eliminate the need for transformations.

With a "real semantics" to work with, one no longer needed sameness at any syntactic level such as Deep Structure to capture sameness of meaning, as observed early on in (Thomason, 1976). And the advent of a "real semantics" helped to end the linguistic wars between generative and interpretive semantics.

But the introduction of "real semantics" led to a new split – whether to get rid of transformations. As Irene Heim said to me[5], having a real semantics "makes the game harder, because it's true of course that a lot of the early work in syntax was in some sense born of lack of imagination about what you could do with semantics. But then once you know that you could do it this way or that way, you know, there is still a question about which way you *should* do it."

Winter-Spring 1972: my first MG seminars at UCLA. (Stockwell: "But when are you going to get back to doing linguistics?") My three main UCLA Ph.Ds – Larry Horn and Frank Heny in linguistics, Michael Bennett in philosophy.

Fall 1972 – I moved to UMass Amherst, still as a syntactician, but also teaching introduction to semantics and seminars in Montague grammar. Terry Parsons moved to UMass at the same time, and we got a joint NSF grant in 1973. Emmon Bach moved to UMass in 1973, and also became a Montague grammarian; the three of us taught jointly in various combinations and supervised the first UMass semantics PhDs together: Robin Cooper 1975, Muffy Siegel 1976, Greg Carlson 1977.

1973 - publication of my first paper on Montague Grammar, (Partee, 1973a), which had earlier appeared in a UCLA Occasional Papers volume edited by Bob Rodman, (Partee, 1972)[6]. I had

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[5] Interview Oct 23, 2013, Cambridge, MA.

[6] That 1972 UCLA Occasional Papers volume is historic for two reasons. For one, the unicorn on its cover, designed at Bob Rodman's request by his wife Joanne because of Montague's famous example sentence *John seeks a unicorn*, led to the unicorn being adopted for many years as the "mascot" of Montague grammar (see my t-shirt in the group photo from the 1978 Konstanz conference in (Bäuerle et

given the corresponding talk at a workshop at the University of Western Ontario in April 1972, with a little help from my friends the philosophers -- Bill Harper, one of the conference organizers, recalls the evening before my talk, somewhere upstairs with a whole gang helping me – David Kaplan, David Lewis, Dana Scott, Rich Thomason, Bob Stalnaker, Bas van Fraassen, Bill Harper … I remain grateful!

1973 – publication of Cresswell's *Logics and Languages*. It had reached Konstanz earlier.

Spring 1973 – The earliest international conference on formal semantics (construed broadly) of natural language was organized by Ed Keenan at Cambridge University in 1973; eighteen of the twenty-five published contributions in (Keenan, 1975) were by Europeans, including Östen Dahl, Hans Kamp, Peter Seuren, John Lyons, Renate Bartsch, Arnim von Stechow, Franz von Kutschera, Carl Heidrich, and Theo Vennemann. Americans there included David Lewis, Barbara Partee, George Lakoff, Stephen Isard, Ed Keenan, Haj Ross. The term 'formal semantics' was not common then outside of logic but soon gained ground among like-minded semanticists who weren't all strictly Montagovian, Keenan being a prime example.

1974: Publication of Montague's Formal Philosophy (Montague, 1974), edited and with extended introduction by Rich Thomason.

1974: Michael Bennett's UCLA dissertation (Bennett, 1974). It was co-chaired by Kaplan and Partee – it was originally to have been chaired by Montague.

Summer 1974 – The LSA's then-annual Linguistic Institute was put on by UMass Amherst, with semantics and philosophy of language as a major theme, and with a large group of faculty, students, and visitors from all over. My course on Montague grammar had about 80 participants; besides the chance to learn and discuss MG, they all got to know each other, there and in courses by Kamp, Karttunen, Parsons, Dowty, Thomason, Stalnaker, Keenan, Janet Fodor, Bach, …

At the Institute there was a lively 6-week MSSB seminar on Non-Extensional Contexts that I organized, which included Rich Thomason, Bob Stalnaker, David Lewis, Terry Parsons, David Dowty, Ray Jackendoff, Janet Fodor, Ed Keenan, Hans Kamp, Lauri Karttunen, Michael Bennett, Enrique Delacruz, and graduate students Anil Gupta (Thomason's) and Robin Cooper (mine). We had subgroups working on Montague Grammar, Propositional attitudes, Non-declaratives, and "Entia non grata" (fictional entities, intentional identity, intensional transitive verbs).

Other people at the institute for longer or shorter times included Perlmutter and Postal, Max Cresswell, David Kaplan, Jim McCawley, Haj Ross, John Searle, Larry Horn, Polly Jacobson, Barbara Abbott, Östen Dahl. Ivan Sag organized fraternity houses into co-ops, with weekly parties. It was intense!

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al., 1979).) And that volume was also identified by the editors of the *Oxford English Dictionary* as the origin of the term "Montague grammar".

The Institute newsletter, put out by a group of students, had a different title each week – The Morning Star, The Evening Star, Venus, Hesperus, …

By mid-1970's, Montague grammar and related work in formal semantics was flourishing as a cooperative linguistics-and-philosophy enterprise in parts of the U.S., the Netherlands, Germany, Scandinavia (including Oslo and Trondheim), and New Zealand, and individually elsewhere.

The biennial Amsterdam Colloquia, still a major forum in formal semantics, started in the mid-1970's and became international in the late 1970's.

1976 – publication of my edited volume *Montague Grammar* (Partee, 1976) containing contributions by Lewis, Partee, Thomason, Bennett, Rodman, Delacruz, Dowty, Hamblin, Cresswell, Siegel, and Cooper and Parsons. Issues treated in those 1976 papers included extensions of Montague grammar to handle plurals, transformational constructions, aspect, restrictive and non-restrictive relative clauses, factive complements; predicative and attributive adjectives in English and Russian (Siegel); comparatives and positives and semantics of degrees (Cresswell); questions (Hamblin); and intertranslatability of theories of 'Quantifying In' (Cooper and Parsons).

1977 – there was a conference organized by Steven Davis and Marianne Mithun at SUNY Albany; the first international conference on formal semantics held in the US, published as (Davis and Mithun, 1979). Papers included Thomason and Mithun's Montague grammar of a fragment of Mohawk – an early application of MG to typology. My paper offered constraints on the form of a Montague grammar, hinting toward type-driven translation. There's Emmon Bach's "MG and Classical TG", Michael Bennett on mass nouns and mass terms, Groenendijk and Stokhof's first international conference paper, "Infinitives and context", McCawley's "Helpful hints to the ordinary working Montague grammarian", and Terry Parsons's type-schemata solution to the increasing proliferation of types for NPs proposed for plurals, for nominalizations, etc.

1977 – the first issue of *Linguistics and Philosophy*, successor to *Foundations of Language*. The first article was by Lauri Karttunen on the syntax and semantics of questions (Karttunen, 1977), the second by David Dowty on verb aspect and the English 'imperfective' progressive (Dowty, 1977). Later in Volume 1, there were papers by Carlson on bare plurals (Carlson, 1977), Hintikka, König, and Kratzer on *must* and *can* (Kratzer, 1977). That was Angelika Kratzer's first English-language journal publication, and one of Greg Carlson's first three, all 1977.

1978, September: Conference in Konstanz, Semantics from Different Points of View, organized by Arnim von Stechow, Rainer Bäuerle, and Urs Egli. The corresponding volume (Bäuerle et al., 1979) includes a great group photograph with a key to all the participants.

Arnim told me that he organized it to help build a sense of community in semantics within and beyond Germany, since most semanticists in Europe were quite isolated.

Participants and their papers included, among others:

- ❑   Rainer Bäuerle – Questions and answers
- ❑   Max Cresswell – Interval semantics for event expressions
- ❑   Irene Heim – Concealed questions (her first publication)
- ❑   Hans Kamp – Events, instants, and temporal reference
- ❑   Angelika Kratzer – Conditional necessity and possibility
- ❑   David Lewis – Scorekeeping in a language game
- ❑   Arnim von Stechow – Visiting German relatives
- ❑   Barbara Partee – Semantics – Mathematics or psychology?

1978 – The first US 'pre-textbook' - (Dowty, 1978).

1970's - Four textbooks on Montague grammar were published in Germany, the last and best being (Link, 1979); all were reviewed in (Zimmermann, 1981).

1980 – Arnim spent 4 months as a Visiting Professor at UMass Amherst. He and Emmon and I had many intense discussions and interactions. He learned to pronounce "Montague Grammar" with an American accent.

1980 – This was the first time that the Amsterdam Colloquium included invited semanticists from the US; the formal semantics community was becoming increasingly integrated across Europe and the US.

1981 – The first Montague textbook in English:(Dowty et al., 1981).

1982 - Publication of the 2-volume Gamut introduction to logic and formal semantics in Dutch (Gamut, 1982), which was finally translated into English in 1991.

5. An emerging issue in the 70's: Context

At the Staal-Bar-Hillel round table in 1967, Bar-Hillel described context-dependence as one of the major issues that needed to be addressed before logical approaches could handle natural language. Montague replied that "context-dependent sentences present no special problem… Formal systems containing [tensed sentences] are easy to construct. … And a comprehensive formal treatment can be found that will apply to every other sort of indexical reference known to me … one replaces moments by *possible contexts* or *points of reference* …

But in extensions of MG in the US, semantics and pragmatics were strongly separated: semantics put in free variables of various sorts, to be filled in 'later' by some assignment function that represented the 'context'.

At the 1978 Konstanz conference I saw how far ahead of us Arnim and Angelika were; and in

interviewing Jeroen Groenendijk in Amsterdam in 2011 ago I learned that much of their work had also been motivated by wanting a more sophisticated treatment of context-dependence.

By the early 80's, with the work of Heim, Kamp, and the Amsterdam crew, we had context-change potential, dynamics, and a fading of the line between formal semantics and formal pragmatics (the context part).

6. Formal semantics as an autonomous subdiscipline of linguistics, and other later developments.

I think the height of interaction on semantics between linguists and philosophers had passed by 1980, followed in the US by the rise of cognitive science, in which semantics was one of the highly interdisciplinary concerns.

A major development in the 80s was greater specialization of semantics inside of linguistics proper, though always with many individual scholars maintaining links of various kinds within and across disciplines. By the middle of the 1980's the increasing recognition of formal semantics as part of the core curriculum in linguistics was seen in the publication of textbooks and the growing number of departments with more than one semanticist, and a few, like ours, with more than two by the end of the decade.

By the beginning of the 1990's, formal semantics (no longer "Montague grammar", though that's about the time that the term "Montague grammar" made it into the OED) was a fully established field within linguistics, and students were not conscious that the core fields hadn't always been 'phonology, syntax, semantics'. Semantics textbooks published around 1990 included (Bach, 1989, Chierchia and McConnell-Ginet, 1990, Gamut, 1991). Departments with one or two formal semanticists increased in the 1990's.

In the 1980's and 1990's, there was noticeably less interaction between linguists and philosophers in semantics in the U.S., in part because within philosophy interest in the philosophy of language had declined as interest in philosophy of mind increased.

In the 1990's there was some divergence between (parts of) Europe and the US. The ILLC was founded in Amsterdam in the late 1980's, leading to the creation of the new journal JOLLI and the ESSLLI summer schools, with equal weight on language, logic, and computation. The Amsterdam Colloquium also became somewhat more logic-and-computation-heavy. In the US, the journal *Natural Language Semantics* was launched in 1992 by Heim and Kratzer, specifically aiming to integrate formal semantics more closely into linguistic theory, especially to connect semantics with syntactic theory, unlike the older interdisciplinary journal *Linguistics and Philosophy*. The SALT conferences began in 1991, with similar motivation.

But I think there's been more back-and-forth since then, and I don't feel that separation now as much as I did in the 1990's. And it's fine to have a variety of subtypes of interdisciplinary

emphases at different conferences, especially as the field grows and diversifies. And I understand that the conference *Sinn und Bedeutung* was started in 1996 just to increase communication of ideas and bring people together, not to push any particular agenda.

7. Examples of renewed linguistics-philosophy interaction.

When I wrote my semi-autobiographical essay (Partee, 2004), there seemed to be little real linguistics-philosophy interaction. But later I happily came to realize that it's on the increase, and more sophisticated than ever. One reason has been the rise of formal pragmatics in linguistics together with the rise of "contextualism" in several areas of philosophy. Other areas of mutual interest and recent activity include vagueness, and the "judge" parameter with predicates of personal taste and epistemic modals. And there are more.

All of these issues seem to relate in one way or another to the interaction of meaning and context, still a growth area. Since that's always been a strength of the semantic community Arnim helped to build, that's as good a place as any for me to stop. Except for an epilogue especially for and about Arnim.

8. Epilogue – a few of Arnim's "likes", and giving Arnim the last word.

While transcribing my interview with Arnim in May 2011, I was struck by quite a number of places where he inserted "and that I liked" or the like. And that I liked, so I want to report some of them in closing.

Romance philology in his student years was unexciting, "but what I liked already then was the bit of historical linguistics, so from Vulgar Latin to French etc – that I liked."

"In Bonn (62-64) I had a girlfriend who was a mathematician, so I had already linear algebra, and the first contact with logic – that I liked."

"Someone recommended to me for my voyage to the Phillipines (1964) a textbook on logic by - I think the man was called Irving Copi – and my feeling was that this was the first subject I understood." He read the whole book and did all the exercises and thought "I have to do that."

[Around 1970] "I was in a train, I had travelled to Hamburg and for some reason I had that book by Hughes and Cresswell about modal logic. I know exactly in the train in the night I read the entire book more or less, I mean without going into all the details, and that I liked a lot."

And later about Cresswell's *Logics and Languages,* "and that I liked a lot".

"And David Lewis, for me, when it comes to the philosophy of language, was always in a way the greatest. … in 'General Semantics' I liked the remarks he makes about the pragmatics, about

the role of illocution, -- he quotes Stenius, this idea about 'saying so makes it so', and [it had been] one of these general objections against truth conditional semantics, that 'what's this performativity, you can't express that', but here it's very clear, it's Stenius, how things get true by saying them. And so I thought, it was really a justification of that kind of semantics against major objections from philosophers of language. 'General Semantics' is one of the things that influenced me a lot. …I'm still completely an adherent of David Lewis."

"Karttunen's semantics of questions is a very great achievement; and also one of the personal heroes for me is Dowty - so that's the reasonable first account about the progressive, still the best we have, so that's the right way to go, and of course also this idea of lexical decomposition, … "

"Categorial grammar, what I liked, and what was so attractive was … that this really has this close fit to ordinary language so that one has the feeling that that must be right. … it's such an attractive idea, and that must be in some sense correct."

Re Montague grammar – "You could criticize the way the syntax is done, yeah, but what is this criticism? We're all in some sense Montagovian grammarians, yeah, so we take the syntax, a reasonable syntax, it must be, and we interpret it and assign truth conditions or something more complicated – maybe to characters -- …, so, fully Montagovian, and this is the framework still full of life, yeah, so that's standard."

B: It's almost as if we used the word "Chomskyan syntax" to mean *Syntactic Structures*. And you can say, well people don't do *Syntactic Structures* anymore. But as a program, it has a continuity, and still –
A: Chomsky has invented an entire discipline, he has really said what in principle syntax should be -- it's a recursive system that generates trees, ..
B: I like Emmon in *Informal Lectures on Formal Semantics*: "Chomsky's great contribution is that English can be understood as a formal language; Montague's great contribution – that it can be understood as an interpreted formal language."
A: Exactly. That's the way –
B: And in that deep sense, they're perfectly compatible.
A: Exactly. And that's what I believe. [chuckling] Right, yeah.

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WORKSHOP "Experimental Methodology in Semantics and Pragmatics"

An Experimental Investigation of the Binding Options of Demonstrative Pronouns

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Abstract. This paper discusses three reading time studies which, first, provide empirical evidence for the claim made by Hinterwimmer (2015) that German demonstrative pronouns can in principle be bound under c-command as long as their binders are not grammatical subjects (Experiments 1 – 3). Second, Experiment 3, which compares demonstrative and personal pronouns, shows that demonstrative pronouns can not only be used in binding configurations in order to avoid ambiguity (as claimed in Patel-Grosz and Grosz, to appear). Rather, sentences containing them are processed as easily as ones containing personal pronouns, provided that the respective binders are direct or indirect objects.

Keywords: demonstrative pronouns, binding, grammatical subjects, prominence.

1. Introduction

While the co-referential behaviour of German demonstrative pronouns (henceforth: DPros) of the *der/die/das* paradigm as opposed to that of personal pronouns (henceforth: PPros) has been an actively investigated research topic for quite some time (see for example Bosch et al. 2003, 2007, Bosch & Umbach 2006, and Schumacher et al. 2016), there is relatively little research on the binding options of German demonstrative pronouns. In Wiltschko (1998), it is claimed that DPros in contrast to PPros cannot be bound at all, while Hinterwimmer (2015) claims that DPros in principle allow binding as long as the binder is not the grammatical subject of the respective sentence. Finally, Patel-Gosz and Grosz (to appear) agree with Hinterwimmer (2015) that DPros can in principle be bound, but additionally assume that they can only be used in binding configurations in order to avoid ambiguity, indicating that they are to be bound by the less prominent of two potential binders.

This paper discusses three reading time studies which show, first, that DPros can be bound by DPs c-commanding them on the surface already, as long as those DPs are not grammatical subjects, and second, that ambiguity avoidance is not required in order to license their use. Rather, sentences containing DPros are processed as easily as sentences containing PPros, even in the absence of any ambiguity, if the respective binders are indirect objects.

The paper is structured as follows. In section 2, previous research on the co-referential and binding options of DPros as opposed to PPros is briefly discussed. In section 3 three experiments, their results and conclusions we draw from them are discussed in detail. Section 4 is the conclusion.

2. Previous Research

On the basis of corpus as well as experimental studies Bosch et al. (2003, 2007) claim that DPros avoid (the referents of) DPs as antecedents that have functioned as the grammatical subject of the immediately preceding sentence (see Kaiser & Trueswell 2008, Kaiser 2011 for related observations concerning DPros in Finnish and Dutch). PPros, in contrast, have a general preference for such antecedents, but accept (the referents of) other DPs as antecedents as well. The DPro in (1) (from Bosch et al. 2007), for example, can only be understood as picking up Peter, while the PPro has a preference for picking up Paul, although it can also be understood as picking up Peter:

(1)   Paul$_i$ wollte gestern mit Peter$_j$ joggen gehen, aber der$_{j/*i}$/er$_{i,j}$ war leider erkältet.   *Paul wanted to go running with Peter yesterday, but unfortunately he {DPro$_{*i/j}$/PPro$_{i/?j}$}had a cold.*

Bosch and Umbach (2006), however, argue on the basis of examples like the one in (2) that DPros do not actually avoid (the referents of) grammatical subjects, but rather discourse topics: The DPro in (2) can only be understood as picking up (the referent of) the grammatical subject of the preceding sentence, but not (there referent of) the indirect object, Karl. According to Bosch and Umbach (2006), this is due to Karl having been established as the discourse topic of the text fragment in (2): The first sentence poses a question concerning Karl that is answered by the two following sentences. Concerning PPros, in contrast, Bosch and Umbach (2006) assume that they have a (weak) preference for discourse topics, which is evidenced by the observation that the PPro in (2) is preferably understood as picking up Karl, but can also quite easily be understood as picking up Peter.

(2)   Woher Karl$_i$ das weiß? Peter$_j$ hat es ihm$_i$ gesagt. Der$_{*i/j}$/Er$_{i,j}$ war gerade hier.
        How does Karl$_i$ know? Peter$_j$ told it to him$_i$. He {DPro$_{*i/j}$/PPro$_{i/j}$} has just been here.

Finally, Bosch and Umbach (2006) propose to account for contrasts like the one in (1) by assuming that grammatical subjects are discourse topics by default. That is, what seems to be (strong) subject avoidance in the case of DPros and (weak) subject preference in the case of PPros is actually the indirect effect of grammatical subjects being default discourse topics.

As already mentioned in section 1, there is relatively little research on the binding behavior of DPros. In Wiltscko (1998), it is claimed that DPros are referential terms corresponding to definite DPs whose NP is empty. Consequently, DPros cannot be bound by c-commanding DPs and not be interpreted as bound variables, in contrast to PPros, which Wiltschko assumes to lack a DP-layer. Evidence for this claim comes from contrasts like the ones between the DPros and the PPros in (3a) and (3b).

(3)   a. [Jeder Mann]$_i$ /Peter$_i$ glaubt, dass *der$_i$/er$_i$ klug ist.
          [*Every man*]$_i$/*Peter*$_i$ *believes that he {*DPro$_i$/PPro$_i$} is smart.*
          b. [Jeder Mann]$_i$ /Peter$_i$ glaubt, dass *dessen$_i$ /seine$_i$ Klugheit die seiner Kollegen bei weitem übersteigt.
          [*Every man*]$_i$/*Peter believes that his {*DPro$_i$/PPro$_i$} smartness surpasses that of his colleagues by far.*

Hinterwimmer (2015) argues on the basis of examples like those in (4) that DPros *can* in principle be bound by DPs c-commanding them either on the surface or at LF, after Quantifier Raising has applied. They just cannot be bound by grammatical subjects. In other words, the contrasts between the PPros and the DPros in sentences like (3a) and (3b) are just due to DPros avoiding grammatical subjects not only as antecedents in discourse, but also as sentence internal binders.

(4)   a. Peter$_i$ glaubt von [jedem Kollegen]$_j$, dass der$_j$ klüger ist als er$_i$.
          Peter$_i$ *believes of* [*every colleague*]$_j$ *that he {DPro$_j$} is smarter than him {Dpro$_i$}.*
          b. Peter stellte [jedem Studenten]$_j$ mindestens eine Frage, die der$_j$ nicht beantworten konnte.
          Peter$_i$ *asked* [*every student*]$_j$ *at least one question that he {Dpro$_j$}*
          could not answer.

In order to account for the co-referential behaviour of DPros reviewed above as well as their binding behaviour, Hinterwimmer (2015) argues that DPros in virtue of being the marked pronoun variant in German (while PPros are the unmarked variant) signal that the default process of identifying the respective antecedent or binder does not apply. Consequently, they come with a lexical presupposition that keeps them from being interpreted as depending on the (currently) most prominent DP. What counts as the (currently) most prominent DP differs in binding and non-binding configurations, though. Binding configurations are defined in structural terms: The (potential) binder has to be contained in the same sentence as its bindee, and the former has to c-command the latter either on the surface or at LF the latest. It is thus to be expected that prominence is defined in structural, i.e. syntactic terms as well. Since grammatical subjects are the syntactically most prominent DPs within their sentences, the lexical presupposition of DPros precludes them from depending on grammatical subjects in (potential) binding configurations. Consequently, DPros may not be bound by grammatical subjects. In non-binding configurations, in contrast, prominence is defined in discourse terms. Consequently, their lexical presupposition precludes DPros from picking up antecedents functioning as discourse topics in such cases.

Patel-Grosz and Grosz (to appear) agree with Hinterwimmer (2015) that DPros can in principle be bound. Their analysis crucially differs from the one in Hinterwimmer (2015), however, as they do not assume DPros to come with a lexical presupposition that prevents them from being interpreted as dependent on the currently most prominent DP. Rather, they assume that the

contrast between PPros and DPros emerges as an indirect effect of DPros being structurally more complex than PPros insofar as they contain an additional functional layer above the DP-layer. The economy principle *Minimize Restrictors!* (Schlenker 2005) thus allows DPros only to be used when there is some benefit that could not be achieved by using a corresponding, structurally less complex and thus less costly PPro.

Concerning the binding behaviour of DPros, Patel-Grosz and Grosz (to appear) assume ambiguity avoidance to be the benefit that licenses the use of DPros: In (4a) and (4b), for example, there are two potential binders, and the DPro can then be used in order to signal binding by the DP that would be dispreferred by default. In (3a) and (3b), in contrast, there is no ambiguity. Using the DPro thus violates *Minimize Restrictors!*, and the sentences are consequently perceived as infelicitous (unless some other male individual has been made salient by the context that DPro could be understood as picking it up).

The data considered in Hinterwimmer (2015) are compatible both with the analysis argued for in that paper and the one of Patel-Grosz and Grosz (to appear), since there are two potential binders (or antecedents) in each case. We thus conducted three self-paced reading experiments that allowed us to investigate which of the two analyses makes the right predictions. In addition to that, we aimed to gain reliable evidence that DPros can be bound by DPs c-commanding them at the surface already: In all sentences discussed in Hinterwimmer (2015) and Patel-Grosz and Grosz (to appear), the DPro is not contained in the same clause as its binder, but in a separate (adjunct or complement) clause that might have been right-adjoined to the matrix clause (see (4a) and (4b) – in (4a) the binder is furthermore contained in a PP and therefore clearly does not c-command the DPro on the surface, but only at LF, after Quantifier Raising has applied). It is therefore possible that DPros, while allowing for bound readings in principle (contra to Wiltschko (1998)), still differ from PPros insofar as they may not be bound by DPs c-commanding them on the surface.

As we will see in section 3, results of the three self-paced reading experiments we conducted

(a) provide empirical evidence for the claim that DPros receive bound readings as long as their binders are not grammatical subjects,

(b) show that DPros can be bound by DPs that c-command them on the surface already and are contained in the same clause, and

(c) suggest that DPros allow for bound readings as easily as PPros (as long as the binder is not a grammatical subject) even if there is no ambiguity involved since there is only one potential binder.

3. The Experiments

3.1 Overview of Experiments and Predictions

All three experiments were word-by-word self-paced reading experiments in which participants read single sentences containing two full (i.e. non-pronominal) DPs and the possessive masculine singular DPro DESSEN (Experiments 1, 2) or, in half of the test sentences, the possessive masculine singular PPro SEINEN, and in the other half DESSEN (Experiment 3). One full DP was always morphologically marked for masculine gender with the second full DP being marked for feminine gender. Importantly, the morphological marking of the included pronouns (i.e. masculine singular) only licensed their interpretation as being bound by the DP marked for masculine gender. We constructed two versions of each test sentence. In one version, the masculine DP was the grammatical subject and the feminine DP the indirect object, with both DPs occurring in canonical position. In the other version, the DPs were reversed, i.e. the masculine DP was the indirect object and the feminine DP the subject. The DPro or PPro was always contained in the DP functioning as the direct object. Note that there is clear empirical evidence that not only subjects, but also indirect objects c-command direct objects in their respective canonical positions in German: First, the reflexive pronoun in (5a) and (5b) cannot only be interpreted as bound by the respective subject, *Hans* in (5a), and *Peter* in (5b), but also as bound by the indirect object, *dem Studenten* ('the student'). Second, the observation that the proper name *Maria* in (6a) cannot be interpreted as co-referential with the PPro *ihr* can easily be accounted for as a Principle C violation if the indirect object c-commands the direct one and everything contained in it. The pronouns in our test sentences were thus always c-commanded by both full DPs.

(5)   a. Hans$_i$ zeigte [dem Studenten]$_j$ ein Bild von sich$_{i,j}$.
        Hans$_i$ showed [the student]$_{i,j}$ a picture of himself$_{i,j}$.
        b. Peter$_i$ stellte [dem Studenten]$_j$ eine Frage über sich$_{i,j}$.
        Peter$_i$ asked [the student]$_{i,j}$ a question about himself$_{i,j}$.

(6)   a. *Hans gab ihr$_i$ Marias$_i$ Buch.
        **Hans gave her$_i$ Maria$_i$'s book.*
        b. Hans gab Maria$_i$ ihr$_i$ Buch.
        Hans gave Maria$_i$ her$_i$ book.

Now, if DPros can

        (a) generally not be bound (as in Wiltschko 1998), or

(b) not be bound by DPs c-commanding them on the surface and contained within the same clause (see section 1 above),

(c) not be used when no ambiguity is involved (as in Patel-Grosz and Grosz to appear)

there should be no reading time differences between the two versions of experimental sentences in Experiments 1 and 2. That is, readers should always slow down when or shortly after reading the DPro DESSEN, independently of whether the masculine DP is the subject or the indirect object. The reason is that participants should not be able to interpret the DPro as being bound without violating a constraint. In addition to that, in the absence of a contextually provided alternative male individual there is no other option for interpreting the DPro, and accommodating such an individual should be costly and thus lead to a reading slow-down as well. If DPros only avoid grammatical subjects as binders (Hinterwimmer 2015), in contrast, a reading slow-down is only predicted in those cases where the subject is masculine and the indirect object feminine compared to when the positions are reversed.

Now, it is conceivable that while subject binding violates a separate constraint, DPros are generally dispreferred as compared to PPros in the absence of ambiguity (cf. Patel-Grosz and Grosz to appear). It would thus be predicted that, in Experiment 3, sentences with DESSEN should always be read slower than ones with SEINEN (while ones with DESSEN where the masculine DP is the subject should be read even slower than ones with DESSEN where the masculine DP is the indirect object). If DPros are not generally dispreferred, but only disallow binding by subjects (Hinterwimmer 2015), no difference between sentences with PPros and ones with DPros is predicted in cases where the masculine DP is the indirect object, but only in cases where the masculine DP is the subject.

3.2 Experiment 1

In Experiment 1, participants read single sentences and occasionally answered comprehension questions. In this experiment, we manipulated the gender of the subject and the indirect object DP while introducing a DPro shortly after indirect object encounter. Both full DPs were always referential, i.e. proper names or definite DPs. In the masculine indirect object condition, the subject was marked for feminine gender. In the masculine subject condition, the indirect object was marked for feminine gender. We predicted a general tendency of readers to interpret the DPro as bound by the indirect object rather than the subject of the sentence, resulting in faster reading times when the indirect object was masculine than when it was feminine.

Method

Participants. 24 students from the University of Cologne participated in this experiment for course credit or monetary compensation (EUR 4). All participants were native speakers of German and reported normal or corrected-to-normal vision.

Materials. We constructed a total of 20 experimental sentences. All sentences introduced exactly two human referents. Referents were introduced with a proper name (e.g., MR. BRUNN) or with a definite DP (e.g., THE ARTIST). One referent was male (masculine gender) and the other one female (feminine gender). In each sentence, one referent was the subject and the other the indirect object. Importantly, the sentences were constructed such that the referents could be reversed without any further changes to the materials. Sentences therefore either appeared in a male subject/female indirect object condition, which we refer to as the *male subject condition*, or in a female subject/male indirect object condition, which we refer to as the *male indirect object condition*. Reversing subjects and indirect objects lead to a total of 40 experimental sentences, half of which were male subject and half of which were male indirect object. An example along with the English translations is provided in (7a) and (7b).

All experimental sentences contained the DPro DESSEN (HIS), which occurred shortly after the second, i.e. the indirect object referent. Crucially, the morphological marking of the DPro only allowed its interpretation as bound by the referent marked for masculine gender, regardless of whether the referent was the subject or indirect object. That is, DESSEN could only be interpreted as bound by MR. BRUNN in both (7a) and (7b).

(7)   a. Frau Meyer kocht Herrn Brunn **dessen liebstes Essen, weil er** sich das gewünscht
          hatte. (*male indirect object condition*)
          Mrs. Meyer cooks Mr. Brunn his favorite dish, because he had asked for it.
          b. Herr Brunn kocht Frau Meyer **dessen liebstes Essen, weil er** sich das gewünscht hatte.
          (*male subject condition*)
          Mr. Brunn cooks Mrs. Meyer his favorite dish, because he had asked for it.

In all experimental sentences, our region of interest started with the DPro and spanned over the subsequent four words (marked in boldface in (7a,b)). Most importantly for our comparison of male indirect object and male subject readings, regions of interest were exactly the same across conditions.

In addition to experimental sentences, we also constructed 20 distractor sentences to distract participants from the manipulation of interest. Distractor items contained semantically ambiguous words (homonyms) such as BANK and CALF. The first part of these sentences contained the homonym while the second part disambiguated the homonym towards the less frequent meaning (e.g., the river meaning of BANK). Finally, materials also included 40 additional filler sentences, which resembled experimental sentences in length and structure.

All experimental, distractor, and filler sentences were counterbalanced across two presentation lists. Each list contained 20 experimental, 20 distractor, and 40 filler sentences. All sentences that were in the male indirect object version in one list were in the male subject version in the other list. Finally, to make sure that participants carefully read our stimuli, 20 of the filler sentences were followed by a yes-no comprehension question.

Procedure

All trials started with sequences of underscores. Each sequence represented a word and each underscore within a sequence a letter. Participants read the first word of a sentence by pressing the space bar. Each subsequent button press triggered the presentation of the next word while letters of the preceding word were again replaced by underscores. Thus, participants read all sentences word by word.

After participants had read the last word of a sentence and pressed the space bar again, they either saw the word WEITER? (CONTINUE?) and pressed the "yes" key to read the next sentence, or they encountered a comprehension question which was either true, requiring a "yes" response or false, requiring a "no" response. The interstimulus interval was 1 s. Prior to the main experiment, participants received four practice sentences to familiarize themselves with the reading paradigm. Feedback was provided during the practice session but not during the main experiment.

Results and Discussion

Overall accuracy to comprehension questions was 94%. Reading times were elicited and analyzed for the five words of interest. For example, we analyzed reading times for the words DESSEN LIEBSTES ESSEN, WEIL ER, in (7a-b). Reading time comparisons were conducted between male indirect object (7a) and male subject versions (7b). Thus, we individually compared reading times of DESSEN, LIEBSTES, ESSEN, WEIL, and ER, in (7a) and (7b). Recall that our prediction was that reading times should be longer for the male subject than the male indirect object versions.

Mean reading times and 95% confidence intervals for each word region (word 1 – word 5) are plotted in Figure 1. Prior to statistical analysis, reading times faster than 200 ms and slower than 2000 ms were classified outliers and excluded (0.5% of the data). All other reading times were log-transformed individually for each word region (word 1 – word 5) using Box-Cox power transformations. We tested differences between the male indirect object and male subject versions performing linear mixed effects regressions including random intercepts and slopes for participants and items. While reading times were included as dependent measure, preference (male object vs. male subject reading) was included as independent variable and included as a random slope for participants and items. Preference was centered prior to analysis. P-values were calculated on the assumption that our models' intercepts are normally distributed. For each word region, we fitted an individual model.

For first, fourth, and fifth words of interest, we did not obtain any reliable reading time differences between the male object and the male subject reading of the pronoun, ts < 1.4, ps > .1. However, for the second word, the observed reading time difference trended in the predicted direction, $\beta = 7.00\text{e-}04$, $SE = 4.27\text{e-}04$, $t = 1.64$, $p = .1$, while it reached full significance for the third word, $\beta = 6.11\text{e-}04$, $SE = 2.02\text{e-}04$, $t = 3.02$, $p = .003$.

Figure 1: Mean reading times and 95% confidence intervals of words of interest $(1 - 5)$ in Experiment 1.
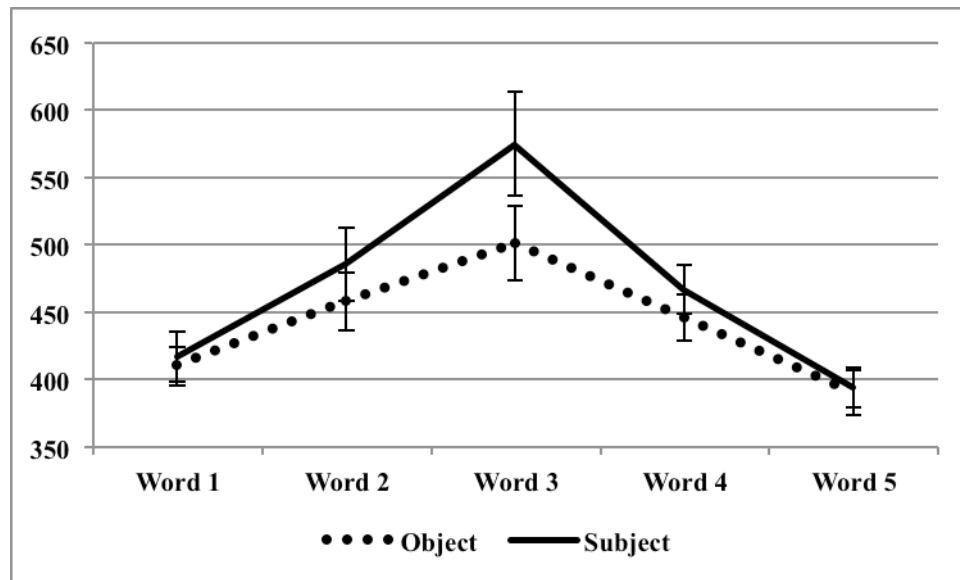
Taken together, then, our region of interest was read faster when the referent functioning as the indirect object was marked for masculine gender compared to when it was marked for feminine gender. That is, participants read the five words of interest faster when they could interpret the DPro as bound by the indirect object, because it matched in gender, than when they needed to interpret it as bound by the subject, because indirect object and DPro were of different gender. This finding indicates that DPros (a) can in principle be bound by DPs that are contained within the same clause and c-command them on the surface already, even in the absence of any ambiguity, and (b) avoid DPs functioning as grammatical subjects as binders.

3.3 Experiment 2

Experiment 2 was identical to Experiment 1 in all respects except for the choice of non-pronominal DPs: The male DP was always quantificational. By this, we wanted to ensure that DPros are indeed capable of receiving a bound variable interpretation under local conditions, i.e. in cases where the quantificational DP is contained within the same clause.

Method

Participants. 24 students from the University of Cologne participated in this experiment for course credit or monetary compensation (EUR 4). All participants were native speakers of German and reported normal or corrected-to-normal vision.

Materials. We constructed 24 experimental sentences, each again containing exactly one masculine marked and one feminine marked full DP. While the general structure of the sentences was identical to the items of Experiments 1, the masculine marked DP was always a quantificational DP headed by JEDER (EVERY/EACH). An example is provided in (8).

(8)   a. Frau Bauer bringt jedem Buchhalter **dessen neue Daten, die schon** lange fällig waren.
          (*male indirect object condition*)
          Mrs. Bauer brings every accountant his new data, which have been overdue for a while.
          b. Jeder Buchhalter bringt Frau Bauer **dessen neue Daten, die schon** lange fällig waren.
          (*male subject interpretation*)
          Every accountant brings Mrs. Bauer his new data, which have been overdue for a while.

Like for Experiments 1, we were interested in reading time differences between male indirect object and male subject conditions for the five regions of interest. The first word of these regions was again the DPro DESSEN. We included the same 20 distractor items in Experiment 2 that were included in Experiment 1 along with an additional 60 filler sentences that were similar in structure to the experimental sentences. All items were counterbalanced across two presentation lists, such that each list contained 12 experimental sentences with a masculine and 12 with a feminine DP functioning as the indirect object. Comprehension questions were presented for 40 filler sentences.

Procedure

The procedure was the same as in Experiment 1.

Results and Discussion

Participants answered correctly to 97% of the comprehension questions. Reading times were elicited and analyzed for the five regions of interest individually, comparing male indirect object with male subject versions. Mean reading times and 95% confidence intervals for each word (word 1 – word 5) are plotted in Figure 2. Prior to statistical analyses, reading times faster than 200 ms and slower than 2000 ms were excluded as outliers (1% of the data). The remaining reading times were log-transformed for each word of interest individually using Box-Cox power transformations.

Mixed effects models were fitted for each word of interest. The dependent measure was reading time. The independent variable was preference (male indirect object vs. male subject), and was centered. Random intercepts and a random slope (preference) were included for participants and items. P-values were calculated on the assumption that our models' intercepts are normally distributed.

Figure 2: Mean reading times and 95% confidence intervals of words of interest $(1 - 5)$ in Experiment 2.
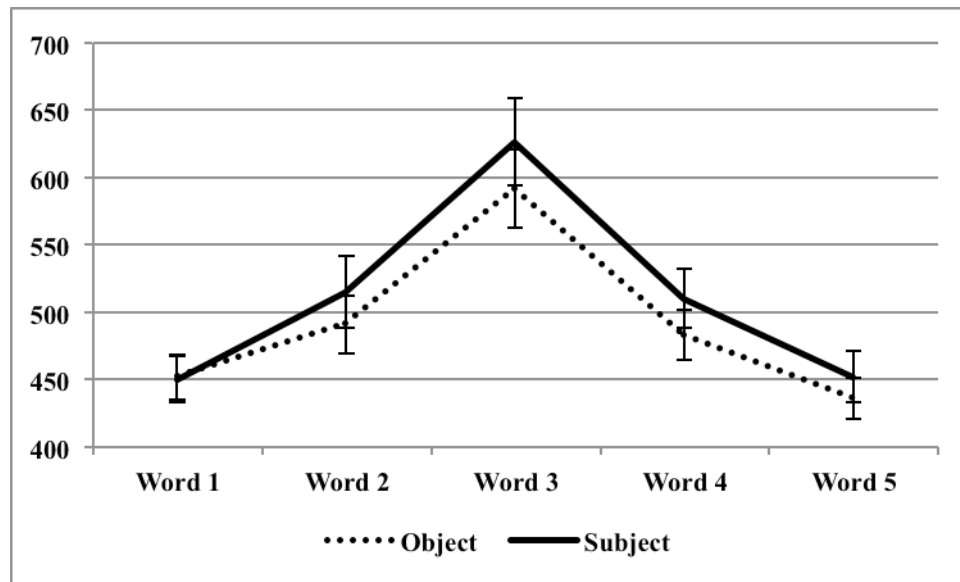
Results for Experiment 2 replicate those of Experiment 1. We failed to find a statistically reliable reading time difference between male indirect object and male subject condition for the first, second, and fifth word, ts < 1.5, ps $> .2$. However, we did elicit a reliable difference for the third, $\beta = 2.71\text{e-}03$, $SE = 1.28\text{e-}03$, $t = 2.11$, $p = .035$, and a marginal difference for the fourth word of interest, $\beta = 7.69\text{e-}05$, $SE = 4.05\text{e-}05$, $t = 1.90$, $p = .058$. The close resemblance of the obtained data of Experiments 1 and 2 strongly suggests that DPros can be interpreted as locally bound variables as long as the (potential) binder is not the grammatical subject of the respective sentence.

3.4 Experiment 3

The results of Experiments 1 and 2 provide clear empirical evidence that DPros can be bound by non-subjects c-commanding them on the surface already. They also provide evidence against the analysis proposed by Patel-Grosz and Grosz (to appear) insofar as it predicts a slow-down in reading times in both subject and indirect object conditions: Since there is no ambiguity, using a DPro instead of a PPro should be infelicitous or, at least, dispreferred in both cases. It is still conceivable, though, that Patel-Grosz and Grosz (to appear) are correct in their assumption that DPros are in fact dispreferred in binding configurations that not involving any ambiguity, but that interpreting a DPro as bound by a grammatical subject violates an additional constraint. In other words, since we only compared sentences with DPros, it could be the case that both the male subject and male indirect object versions of our test sentences are read more slowly than otherwise identical sentences with PPros, but that the male subject versions are read even more

slowly than the male indirect object versions. In addition, so far we cannot exclude an alternative explanation of the reading time differences between the two conditions in terms of recency: In the male subject condition the number of words intervening between the binder and the DPro is higher than in the male indirect object condition.

We therefore conducted a third experiment that would allow us to (a) gain evidence that DPros are not generally dispreferred in the absence of ambiguity and (b) exclude the alternative account of the results of Experiments 1 and 2 just sketched. In Experiment 3, we generated four versions of each test sentence: One in the male indirect object condition with a DPro and one with a PPro, and one in the male subject condition with a DPro and one with a PPro. If DPros are generally dispreferred in binding configurations without ambiguity, the variants with the DPro should generally be read slower than the ones with the PPro (while the male subject versions with the DPro should be read even more slowly than the male indirect object versions with the PPro, in line with the results of Experiments 1 and 2). If the alternative explanation of the results of Experiments 1 and 2 in terms of linear distance holds, the sentences in the male subject conditions should consistently be read more slowly than the ones in the male indirect object condition, irrespective of pronoun type, i.e. there should be no reading time differences between the versions with a DPro and the ones with a PPro. The analysis proposed by Hinterwimmer (2015), in contrast, predicts that only the male subject versions with a DPro should lead to a reading slow-down since they violate a constraint, while there should be no great reading time differences between the remaining three conditions.

Method

Participants. 56 students from the University of Cologne participated in this experiment for course credit or monetary compensation (EUR 4). All participants were native speakers of German and reported normal or corrected-to-normal vision.

Materials. The same materials as in Experiment 1 were used with the exception that sentences either included the DPro DESSEN or the PPro SEINEN. An example is provided in (9).

(9)   a. Frau Meyer kocht Herrn Brunn **dessen liebstes Essen**, **weil er** sich das gewünscht hatte.
a´. Frau Meyer kocht Herrn Brunn **sein liebstes Essen**, **weil er** sich das gewünscht hatte.
Mrs. Meyer cooks Mr. Brunn his (DPro/PPro) favorite dish, because he had asked for it.
b. Herr Brunn kocht Frau Meyer **dessen liebstes Essen**, **weil er** sich das gewünscht hatte
b.´ Herrn Brunn kocht Frau Meyer **sein liebstes Essen**, **weil er** sich das gewünscht hatte.
Mr. Brunn cooks Mrs. Meyer his (DPro/PPro) favorite dish, because he had asked for it.

Procedure

The procedure was the same as in Experiments 1 and 2.

Results and Discussion

Overall accuracy for the comprehension questions was again high, with 94%. Mean reading times and 95% confidence intervals for each word region (word 1 – word 5) are plotted in Figure 3. As for Experiments 1 and 2, prior to statistical analysis, reading times faster than 200 ms and slower than 2000 ms were excluded (0.1% of the data). All remaining reading times were log-transformed individually for each word region (word 1 – word 5) using Box-Cox power transformations. Linear mixed effects regressions were used to test for differences between male indirect object and male subject versions. We included random intercepts and random slopes for participants and items. While reading times were included as dependent measure, reading (male indirect object vs. male subject) and pronoun type (DPro vs. PPro) were included as independent variables and also included as a random slope for participants and items. Reading and pronoun type were centered prior to analysis and p-values calculated on the assumption that our models' intercepts are normally distributed. For each word region, we fitted an individual model.

For first, fourth, and fifth words of our region of interest, we failed to find any reliable reading time differences between conditions, ts < 0.9, ps > .3. However, for the second word region, male indirect object versions were read faster than male subject versions, but only when the sentence included a DPro, leading to a Reading x Pronoun Type interaction $\beta = 12.75e\text{-}04$, $SE = 5.57e\text{-}04$, $t = 2.29$, $p = .022$. The same was true for the third word region, $\beta = 5.63e\text{-}04$, $SE = 2.85e\text{-}04$, $t = 1.97$, $p = .049$. For this region, the model also revealed a main effect of pronoun type, $\beta = 4.49e\text{-}04$, $SE = 1.85e\text{-}04$, $t = 2.42$, $p = .015$, which was due to male subject versions with a DPro being read much more slowly than the three other conditions.

Figure 3: Mean reading times and confidence intervals of words of interest (1 – 5) in Experiment 3.
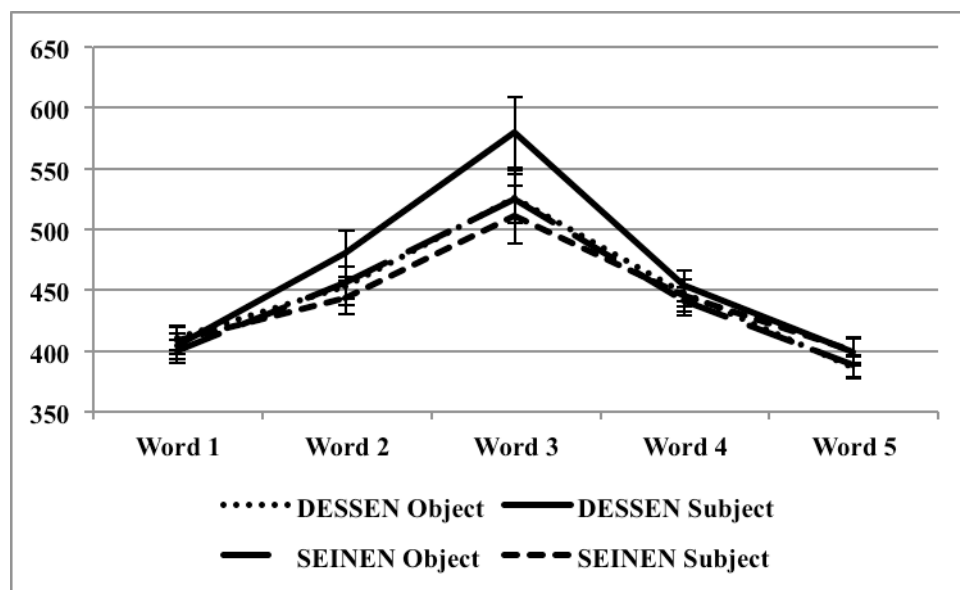
Taken together, sentences with DPros were read more slowly than sentences with PPros in the male subject condition, but as fast as sentences with PPros in the male indirect object condition. Sentences with PPros in the male subject condition were read as fast as sentences with PPros in the male indirect object condition. This provides good empirical evidence that, first, DPros are not generally dispreferred in binding configurations in the absence of ambiguity, but only when the only available binder is the grammatical subject of the respective sentence. Second, our data clearly show that linear distance does not play a significant role since we should then have elicited a reading slow-down not only in the male subject versions with a DPro, but also in the ones with a PPro, compared to its indirect object version.

4. Conclusion

In this paper we investigated the conditions under which DPros can be bound. We have discussed three self-paced reading time studies which provide empirical evidence for the analysis proposed by Hinterwimmer (2015). According to Hinterwimmer, DPros are prohibited from being interpreted as the dependent on the currently most prominent DP. Since syntactic prominence is decisive in (potential) binding configurations, and since grammatical subjects are the syntactically most prominent DP within the respective clause, DPros are in effect prohibited from being bound by grammatical subjects. Nothing precludes them from being bound by other DPs c-commanding them on the surface or at LF the latest, however. The experiments also show that ambiguity avoidance is not required in order to license the use of DPros in binding configurations, contra Patel-Grosz and Grosz (to appear).

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Reluctant Acceptance of the Literal Truth: Eye Tracking in the Covered Box Paradigm[1]

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Abstract. Since Bott and Noveck (2004), there has been an ongoing discussion about whether scalar implicatures are delayed in online processing relative to literal meaning. Bott and Noveck (2004) provided Reaction Time evidence for such a delay, replicated in a number of later variations of their study (e.g., Bott et al., 2012). Breheny et al. (2006) found corresponding delays in self-paced reading. More recently, the issue has been investigated using the visual world paradigm, where results have been more mixed. Huang and Snedeker (2009, and subsequent work) have found delays for eye movements based on the 'not all' implicature of 'some.' But various others, (e.g., Grodner et al. (2010), Breheny et al. (2013), and Degen and Tanenhaus (2011)), report results which they argue show that implicatures are available immediately. Schwarz et al. (2015) added another angle to this picture, by using a sentence picture matching task using a Covered Picture (or Covered Box; henceforth CB; Huang et al., 2013), that allowed RT comparisons both within acceptance (target) and rejection (CB) responses. While replicating the delay for implicature-based rejection responses, they find the reverse pattern for acceptance responses, with faster RTs for implicature-compatible conditions. They propose that delays associated with literal acceptances and implicature-based rejections result from a conflict between the two possible interpretations, rather than reflecting a cost of implicature-calculation. The present experiment extends this approach beyond RTs by combining Visual World eye-tracking with the CB paradigm. The results a) are consistent with the notion that both literal and implicature interpretations are available in parallel; b) show that literal acceptances are nonetheless only provided reluctantly, presumably due to a preference for implicature meanings, in line with Schwarz et al's proposal; and c) suggest that for both literal acceptances and implicature-based rejections, there is a competition effect between the two interpretations. In addition, the RT data display an implicature-based block-priming effect, suggesting that the resolution of this conflict can be sped up through repeated task-exposure.

Keywords: scalar implicatures, processing, visual world eye tracking

1. Introduction

A major tenet in the modern study of linguistic semantics and pragmatics is that while speakers may perceive the meaning of a given utterance in its totality, it is actually a complex construct

out of various distinct ingredients that constitute different aspects of meaning, such as literal/truth-conditional content, conversational implicatures, and presuppositions. One key theoretical question is to understand what aspects of meaning should be differentiated, and what theoretical properties they have. From the perspective of online language processing, an additional question is how these various aspects of meaning arise in real time and how they are combined into the perceived whole of utterance meaning. Pursuing both theoretical and processing perspectives in parallel, raises the additional question as to how answers to each of these questions constrain answers to the other. In the evolving enterprise of studying different aspects of meaning with methods from experimental psycho-linguistics, scalar implicatures have been the main focus of attention for over a decade. Despite the now extensive body of work on the processing of scalar implicatures, many issues remain open, with various theoretical proposals on the market and, partly, conflicting-seeming empirical results under discussion.

The present paper contributes to these ongoing debates in several novel ways. First, while the primary focus in previous work has been on the processes leading to implicature-based responses, we extend the approach by Schwarz et al. (2015) and look at the processes leading to 'literal' responses. Secondly, we introduce a novel methodology, which combines use of the Covered Box paradigm (Huang et al., 2013) with visual world eye tracking. The results a) are consistent with the notion that both literal and implicature interpretations are available in parallel; b) show that literal acceptances are nonetheless only provided reluctantly, presumably due to a preference for implicature meanings, in line with Schwarz et al's proposal; and c) suggest that for both literal acceptances and implicature-based rejections, there is a competition effect between the two interpretations. In addition, the RT data display an implicature-based block-priming effect, suggesting that the resolution of this conflict can be sped up through repeated task-exposure.

The paper is organized as follows: In the remainder of this section , we review the basic theoretical and experimental background. Next we briefly review the approach of Schwarz et al. (2015), which we take as a starting point for the present study. Section 3 presents the new experimental design and discusses its results. Section 4 concludes.

1.1. Theoretical Background

Following the seminal work by Grice (1975), conversational implicatures are commonly seen as an ingredient of the overall conveyed meaning that goes beyond what is conventionally encoded as the literal meaning of the lexical expressions involved. To illustrate the case of scalar implicatures, which we will be concerned with, the sentence in (1a) commonly conveys (1b)

(1)   a.   Some of the giraffes have scarves

        b.   Not all of the giraffes have scarves

Crucially, this inference is not obligatorily part of what is conveyed, as illustrated by (2) - implicatures can be cancelled (or suspended):

(2) Some of the giraffes have scarves - in fact, all of them do.

This, and other hallmark properties of implicatures, is standardly captured by assuming that there are (at least) two ingredients factoring into the overall meaning of (1a), the conventionally encoded literal meaning (based on the lexical entry for *some*), and an additional inference, derived as a scalar implicature. The conjunction of the two corresponds to the commonly perceived overall meaning of (1a) that some, but not all, of the giraffes have scarves.

(3) a. **Literal meaning:** Some, and possibly all, of the giraffes have scarves.
    b. **Implicature Inference:** Not all of the giraffes have scarves.

Following the seminal work by Grice (1975) and Horn (1972), the scalar implicature is derived via reasoning about certain alternative sentences that the speaker could have uttered instead. In particular, *some* is associated with a scale of alternatives that includes *all*. In a nutshell, the hearer reasons that the speaker who uttered (2) would have used the corresponding stronger *all*-statement in (4) instead if she had had good evidence for it to be true. The hearer therefore concludes that she must not think it's true (and furthermore, that it is in fact not true if he assumes she is well informed).

(4) All giraffes have scarves.

While there are many important ongoing theoretical debates about how best to implement the derivation of scalar implicatures based on such alternatives, this brief summary shall suffice for our purposes.

1.2. Experimental Background

While the original theoretical accounts of scalar implicatures were developed within philosophy of language and did not intend to make any claims about real-time processes in the human mind during language comprehension, the nascent field of experimental pragmatics has embarked on linking theoretical perspectives with accounts of implicature computation in online language processing. The derivational nature of the Gricean story lends itself to a step-wise processing account, often referred to as a 'Literal First' model (Huang and Snedeker, 2009). On this view, each time a scalar term such as *some* is encountered, the literal 'some, and possibly all' meaning is accessed

first, and the implicature inference is derived in a second step through effortful reasoning that takes time in processing.

In contrast, so-called 'Default' accounts (e.g. Levinson, 2000) are based on the notion that implicatures arise by default, and do not require effortful and time-consuming derivation. When literal interpretations are accessed at all, this happens via cancellation, which is assumed to take place in a subsequent step and thus could plausibly be assumed to take additional time in online processing.

While we're glossing over many details for reasons of space, it is clear that these two options make opposite predictions for the time-course of implicature and literal interpretations in online processing. Literal First accounts predict literal interpretations to precede implicature interpretations, whereas default accounts predict the opposite. A substantial amount of work over the last decade or so has been devoted to determining the time-course of implicature computation as compared to the computation of literal meaning. A large number of studies, starting with Bott and Noveck (2004), found implicature-based responses to be associated with a delay. Their paradigm used a truth-value judgment paradigm and presented subjects with sentences such as *Some elephants are mammals*, which could be judged either true, on a literal interpretation, or false, on an implicature interpretation, and assessed the time-course of the relevant responses in various ways. They find that implicature-based responses take more time than literal responses when subjects respond without time-constraints, and that literal responses become more frequent when the response-time window is narrowly constrained. This is argued to support a Literal First model. The general result has been replicated in a number of later variations of their study (e.g., Bott et al., 2012). Breheny et al. (2006) found corresponding delays in self-paced reading. More recently, the issue has been investigated using the visual world paradigm (Tanenhaus et al., 1995), where results have been more mixed. Huang and Snedeker (2009, and subsequent work) have found delays for eye movements based on the 'not all' implicature of 'some.' But various others, (e.g., Grodner et al. (2010), Breheny et al. (2013), and Degen and Tanenhaus (2011)), report results which they argue show that implicatures are available immediately. Given these latest results, the literature remains divided as to whether or not there is convincing support for delays being associated with implicature computation. While many other aspects of implicatures have been explored experimentally in recent years as well, such as their acquisition (Noveck 2001; Papafragou and Musolino 2003; Gualmini et al. 2001; Chierchia et al. 2001 a.o.), or their relation to other non-literal aspects of meaning (Chemla and Bott 2014; Tieu et al. 2015; Romoli and Schwarz 2015; Bill et al. 2014 a.o.), one issue that has hardly received any attention is what the processes and related time-course effects for literal interpretations of scalar sentences are. In the following section, we report an initial attempt of ours to fill this gap with a novel paradigm for assessing response times. Next, we turn to the present experiment, which extends this approach to visual world eye tracking.

2. Reaction Time Evidence for Competition between Readings

A crucial issue that arises for much of the previous work looking at response times for implicature vs. literal interpretations is that it commonly requires comparing response times for different

(Literal)   (Implicature)   (False)
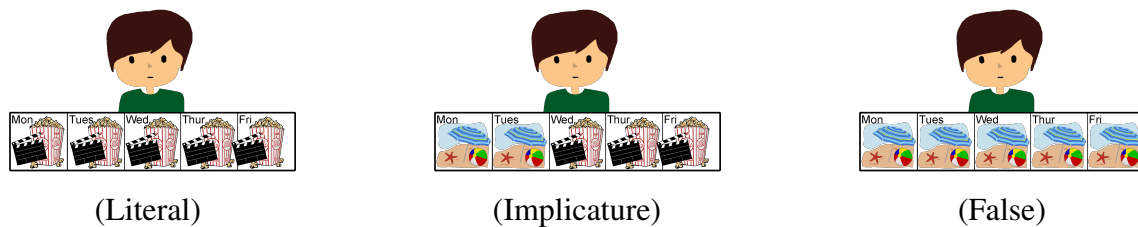
Sentence: *Henry sometimes went to the movies this week.*

Figure 1: Target picture variants for *sometimes* conditions from Schwarz et al. (2015).

types of responses, typically True vs. False. This raises the question of whether there might be independent timing factors for the types of response, which could be separate from the nature of the underlying interpretation (literal vs. implicature) leading to it. Bott and Noveck (2004) were already aware of this and tried to guard against it in several ways. However, another approach of getting at the issue can be pursued by comparing alike responses, e.g., by assessing how easy (or fast) it is to accept statements that are only true on a literal interpretation, as compared to acceptance of statements that are also compatible with an implicature interpretation. Romoli and Schwarz (2015) utilized this approach in a picture matching task looking at implicatures (and presuppositions) under negation, and found that acceptance of pictures that were only consistent with a literal interpretation was slower than that of pictures consistent with an implicature interpretation. Schwarz et al. (2015) further generalized this approach by pursuing comparisons between both rejection and acceptance judgments and looking at implicatures in affirmative and negative sentences. As the new experiment reported below directly builds on these results, we review the latter study in some detail here.

The study used images with calendar strips representing activities of individuals on a given day of the week. A sentence and two pictures were displayed for each trial, though one was 'hidden' from view, represented by a black box. Instructions specified that only one picture would be a match for the displayed sentence, so that subjects should choose the hidden picture precisely if the visible picture did not match the sentence. Figure 1 illustrates the visible picture variants and an example sentence. Crucial comparisons concerned response times for acceptance of the Literal picture and the Implicature picture on the one hand, and rejections of the Literal and the False picture on the other. For the latter, the results displayed the standard pattern, where implicature-based rejections take longer than ones where rejection is possible based on literal meaning alone. This is in line with Bott & Noveck's findings, although it makes a different comparison by focusing on rejection responses for both cases. For acceptances, the pattern was in line with that found by Romoli and Schwarz (2015) for implicatures under negation (which also yielded the same pattern of results in the Schwarz et al. 2015 version). These effects were reflected in statistical interactions between response type and picture condition, as well as simple effects between pictures within acceptances and rejections respectively.
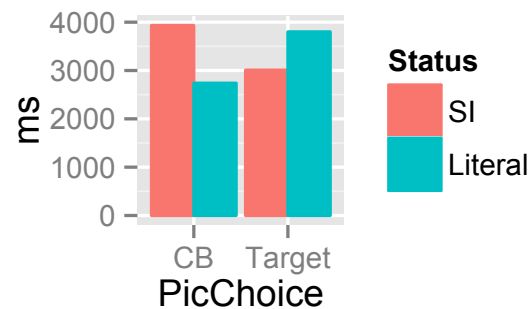
Figure 2: Response times for Covered Box (CB) and Target choices by condition from Schwarz et al. (2015).

In sum, rejections that can be based on literal meaning alone are faster than rejections that require the implicature, but acceptances of pictures consistent with the implicature are faster than acceptances of pictures that are only compatible with the literal interpretation. Schwarz et al. (2015) note that this cannot be accounted for solely in terms of delays for implicature computation. The delay in accepting literal pictures is unexpected from that perspective. A straightforward descriptive generalization about these results, however, is that delays arise precisely in those cases where more than one response is possible, in this case, the Literal picture. That is, accepting the Literal picture is slower than accepting the Implicature picture, and rejecting it is slower than rejecting the False picture. Given this pattern, a plausible hypothesis is that the delays in response times are due to a competition effect of sorts. Schwarz et al. (2015) frame this in terms of opposing pressures: on the one hand, implicature interpretations are generally strongly preferred, and in fact are often perceived to be THE meaning of *some*-statements by naive speakers (as can be confirmed by anyone teaching the existential quantifier $\exists$ to students of Predicate Logic). On the other hand, it is commonly assumed that some form of Charity principle plays a strong role in language comprehension, which leads hearers to try to adopt an interpretation that makes the speaker's utterance true (in our paradigm, this means to prefer the visible picture to match the sentence). These two pressures oppose one another in the Literal condition, in that the first favors rejecting the visible picture (i.e., selecting the covered box), whereas the second favors accepting the visible picture. A plausible interpretation of the response time delays then is to see them as due to having to resolve the conflict between these two options, i.e., as a competition effect of sorts. Such an account, which extends to other response time results in the literature, does not need to allude to delays in implicature computation, though it is also not incompatible with such delays (as we will discuss further when looking at the current experiment's results). To the extent that these are supported by more fine-grained online processing results, such as from visual world eye tracking, it might well be the case that implicatures arise after literal meaning, leading to the type of effect found by Huang and Snedeker (2009), but that response time effects, which commonly are larger than those found in eye tracking, are at least in part, or perhaps even entirely, due to the competition effect described here. The competition effect itself can also be further elucidated by using the more

fine-grained information that eye tracking affords. This is exactly what the experiment reported below aims to achieve.

3. A Novel Paradigm: Visual World Eye Tracking with a Covered Box

The visual world eye tracking paradigm (Tanenhaus et al., 1995) provides eye movement data relative to a visual scene as a sentence unfolds. It is commonly paired with a picture selection task, where subjects have to identify a picture as a match for the description provided by the sentence. As it provides continuous data as the sentence unfolds, it allows more direct insights into the processes involved in arriving at the final picture selection. This has been used in the study of scalar implicature to great effect (starting with Huang and Snedeker, 2009). Previous work in this area followed the standard approach of focusing on a temporary ambiguity: a sentence such as *Point to the girl that has some of the soccer balls.*, is presented along with pictures where one girl has some, but not all of the soccer balls and another has all of the socks. Up until the second part of *soccer*, a literal interpretation is consistent with either individual, whereas an implicature interpretation is only consistent with the girl with the soccer balls.

The covered box paradigm of Schwarz et al. (2015) allows for the presentation of items where: a) a real choice remains to be made at the end of the sentence, and b) the visible picture candidate for matching the relevant sentence is only consistent with its literal interpretation. Therefore, by combining this approach with the visual world paradigm, we gain further insights into the processes involved in reaching both acceptance and rejection interpretations for both implicature and literal interpretations, which in turn allows us to test more directly for the competition effects posited by Schwarz et al. (2015). To capture any potential effect of having to make a real choice at the end of the sentence, and in particular, of considering visible pictures only consistent with a literal interpretation, we added conditions where the ambiguity was only temporary, as in previous visual world tasks. That is, in these trials the ultimate choice was always the covered box as the visible pictures were incompatible with the literal meaning of the sentence once it unfolded in its entirety. By using a block design with counterbalanced block-order, we were able to investigate effects of globally ambiguous trials on online processing and behavioral response measures, specifically response times.

3.1. Materials & Design

Each trial involved 3 pictures, a target, a distractor, and the covered box, along with an auditorily presented sentence, as illustrated in Figure 3. The sentence always had the format *Some of the NP$_1$ have NP$_2$*, where 'NP$_1$' was an animal name and 'NP$_2$' an accessory. The distractor was never a live option for being a match at any point during the sentence, and was only included to provide a richer visual scene and promote visual exploration (distractor-like pictures were the correct choice on certain filler trials; see below). The covered box was introduced as hiding yet another picture

Target   Distractor

Sentence: *Some of the giraffes have scarves.*
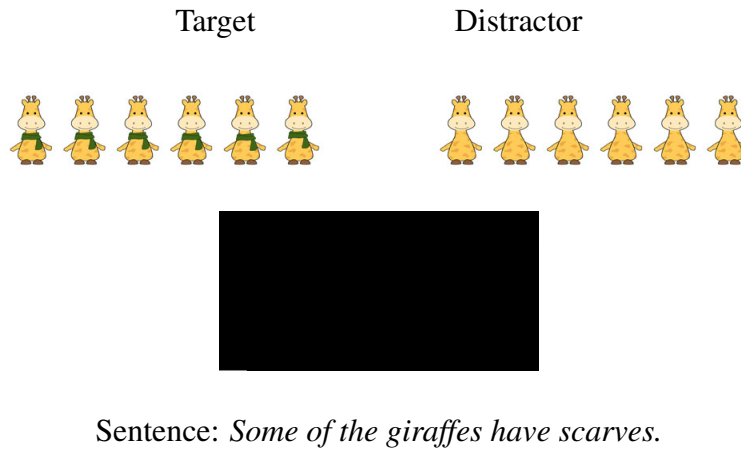
Figure 3: Illustration of trial display in Literal-Global condition.

Implicature-Global   Literal-Global   Implicature-Temp   Literal-Temp
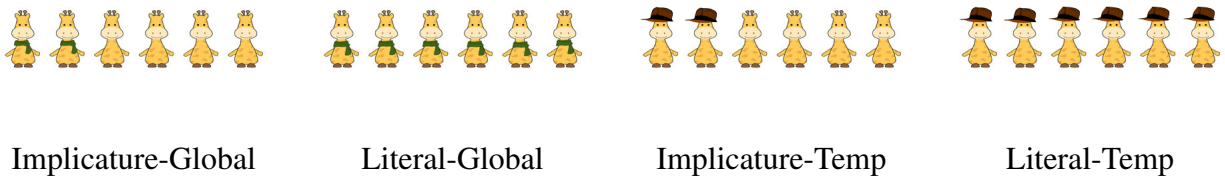
Figure 4: Illustration of target picture variations by condition.

in the instructions, which was to be chosen if and only if none of the visible pictures matched the picture. The target picture was varied along two dimensions, as shown in Fig. 4. First, it either was consistent with the implicature or not, which we encoded as IMPLICATURE vs. LITERAL: in the former variant, only some of the giraffes had a given accessory, whereas in the latter, all did. Secondly, the accessory mentioned in the sentence (e.g., scarf, in Fig. 3) either did or did not match the one displayed in the target picture. When it did (e.g., the giraffes have scarves), the target remained a candidate referent after the sentence was complete (modulo the implicature vs. literal interpretation subjects adopted). When it did not (e.g., when the giraffes wore hats), the covered box was the only viable final response choice, though prior to the sentence-final noun, the target remained a candidate referent (again, modulo the implicature vs. literal interpretation issue). This factor was encoded as GLOBAL vs. TEMP(ORARY), and was blocked in the experimental materials to allow assessment of the influence the two types of trials might have on one another (see details under Procedures below).

A total of 16 experimental items was created, each with variants in the 4 conditions, which were then divided into 4 counter-balanced lists, each with 4 items per condition. Several types of fillers were included as well to conceal the experimental manipulation and to counterbalance various potential issues that could arise from the experimental stimuli:

- 8 fillers with sentences with *some*, parallel to the experimental stimuli, 4 of them with a target picture that was consistent with the implicature, and 4 with a target-like picture (i.e., only some of the animals had a given accessory) but with an accessory different than that mentioned in the sentence, leading to a covered box choice.

- 16 fillers using *none* as the determiner, with pictures that were structurally identical to a counter-balanced set of target pictures, but with the picture corresponding to the distractor as the correct answer choice.

- 16 fillers with definite plurals for NP_1 (e.g., *The giraffes...*), with a target picture where all animals had a given accessory, which matched in 8 fillers and did not match in the other 8.

This selection of fillers ensured a relatively balanced distribution of visible picture vs. covered box choices overall, and within the former, of target-type vs. distractor-type picture choices. Note also that there were no items using the universal quantifier *all*, as we used plural definites instead. Finally, note that there were only 4 items where it ultimately mattered whether or not subjects adopted an implicature or literal interpretation for their response.

3.2. Participants & Procedure

Seventy-eight undergraduate students at the University of Pennsylvania took part in the experiment for course credit. They were seated in front of a monitor and had their eye movements recorded using an EyeLink 1000 eye tracker by SR Research. Each session began with instructions describing the task as involving the selection of a picture, via mouse click, as a match for a description provided by a sentence. Furthermore, the nature of the covered box was explained, and two practice trials with plural definites illustrated when the a visible picture would be chosen and when the covered box would be chosen. Subjects could then ask questions about the task, if any, and the eye tracker was set up. Each subject was assigned to a group that would see one of the counterbalanced lists, which included a block order manipulation, such that half the subjects saw the global conditions first, and the other half the temporary conditions first.

3.3. Results

3.3.1. Responses and Response Patterns

Response accuracy in the unambiguous conditions (both TEMPORARY and IMPLICATURE-GLOBAL) was at ceiling ($> 98\%$ Covered Box and Target choices respectively). The LITERAL-GLOBAL condition yielded 22.5% literal target responses, and 77.5% implicature-based CB responses.
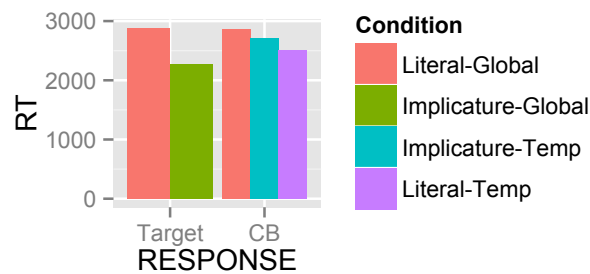
Figure 5: Reaction times by condition and Response.

Turning to the response time data, only trials with appropriate responses (i.e., accurate responses in unambiguous conditions and either response in the LITERAL-GLOBAL condition) were included in the statistical analyses, which used mixed effect models with maximal random effect structures (Barr et al. 2013). The crucial conditions are illustrated by response in Figure 5. A first comparison, parallel to that in Romoli and Schwarz (2015); Schwarz et al. (2015), between target responses in the LITERAL-GLOBAL and IMPLICATURE-GLOBAL Target responses, replicated the previous findings, in that the former are significantly slower than the latter (2887ms vs. 2275ms; $\beta = -599.4$, $SE = 145.4$, $t = -4.12$, $\chi^2 = 13.29$, $p < .001$).

Secondly, covered box choices in the LITERAL-GLOBAL condition were slower than in the LITERAL-TEMP condition (2858ms vs. 2511ms; $\beta = -408.5$, $SE = 164.8$, $t = -2.48$, $\chi^2 = 5.35$, $p < .05$), which is in line with delays for implicature-based rejections standardly reported in the literature: in the latter cases, responses are based on the literal meaning of the final noun phrase (*scarves*), which does not match the accessories in the picture, while in the former case, the only grounds for rejection is an implicature interpretation.

Interestingly, covered box choices in the IMPLICATURE-TEMP condition were also slower than in the LITERAL-TEMP condition (2707ms vs. 2511ms; $\beta = -200.36$, $SE = 80.38$, $t = -2.49$, $\chi^2 = 5.10$, $p < .05$), even though in both cases, the literal meaning suffices to reject the target picture, due to the mismatch between accessories in the sentence and picture. This seems to indicate that temporary compatibility with the implicature affects RTs even when the sentence as a whole is incompatible with the picture based on literal meaning alone.

Finally, considering the impact of the block-order factor (i.e., whether GLOBAL or TEMP trials were seen first), there was a significant effect of order, in that covered box choices in the LITERAL-TEMP condition were faster when they had been preceded by the block of GLOBAL trials. This suggests that an implicature interpretation aided to speed up the rejection of the visible picture in the LITERAL-TEMP condition, but only after previous exposure to GLOBAL trials.

To summarize the response time findings, we replicate the previous results from Romoli and

Schwarz (2015) and Schwarz et al. (2015) in that target choices are faster when the target is compatible with an implicature interpretation. Secondly, we find that rejection of a visible picture purely on the grounds of an implicature interpretation is slower than rejection based on literal meaning, again in line with previous results from Schwarz et al. (2015), though with a slightly different literal-based rejection comparison provided by the TEMP condition. The finding that the IMPLICATURE vs. LITERAL manipulation even had an effect in the TEMP condition is a novel and somewhat surprising finding. The temporary viability of the picture in light of an implicature interpretation seems to make the picture attractive enough to slow down rejection overall, even though rejection can be based on literal meaning alone once the final noun is heard. The block order effect speaks to a similar point, in that previous exposure to GLOBAL trials speeds up rejection in the LITERAL-TEMP condition, which again suggests that an implicature interpretation is at play even in that condition, and that this is facilitated, and perhaps sped up, by previously having seen GLOBAL trials, where the existence of both interpretations is highlighted and a choice between them is forced. We return to this point in the general discussion below.

3.3.2. Eye tracking

For the purposes of analyzing the eye movement data, we computed Target Advantage scores, which here were defined as looks to target – looks to other pictures, time-locked to the auditory onset of crucial expressions, specifically the sentence-initial quantifier (see Fig. 6) and the sentence-final noun (see Fig. 7). Statistical analyses using mixed effect models were conducted on Target Advantage scores transformed to Elogit for 200ms time windows after the relevant onsets.

Starting with the distribution of looks in the GLOBAL conditions (independent of response, effectively pooling the two red lines in the graph in Fig. 6) there is a relative decrease in looks to the target in the LITERAL condition, marginally significant in the 800-1000ms time window and fully significant in the 1000-1200ms time window ($\beta = 1.90$, $SE = 050$, $t = 3.82$, $\chi^2 = 14.47$, $p < .001$). This is comparable to the time-course of implicature-based looking patterns in Huang and Snedeker (2009) and following work.

Given our interest in the emergence of responses based on a literal interpretation, we next turn to a comparison in fixation patterns in IMPLICATURE and LITERAL trials in the GLOBAL conditions that ended in selection of the target (see Fig. 6a). From 1400-1800ms after Q-Onset, there is a significant relative decrease in looks to the target in the LITERAL condition (1400-1600ms: $\beta = 3.03$, $SE = 1.16$, $t = 2.61$, $\chi^2 = 5.12$, $p < .05$; 1600-1800ms: $\beta = 3.56$, $SE = 1.15$, $t = 3.08$, $\chi^2 = 7.08$, $p < .01$), and this effect is still nearly marginally significant from 1800-2000ms ($\beta = 2.57$, $SE = 1.51$, $t = 1.70$, $\chi^2 = 2.57$, $p = .11$). Comparing GLOBAL-LITERAL trials based on the ultimate response (Fig. 6b), a difference in fixation patterns only emerges around 2000ms (1800-2000ms: $\beta = 1.27$, $SE = 0.73$, $t = 1.74$, $\chi^2 = 2.71$, $p < .1$; 2000-2200: $\beta = 2.25$, $SE = 0.61$, $t = 3.69$, $\chi^2 = 9.43$, $p < .01$). In sum, LITERAL target acceptance trials display a
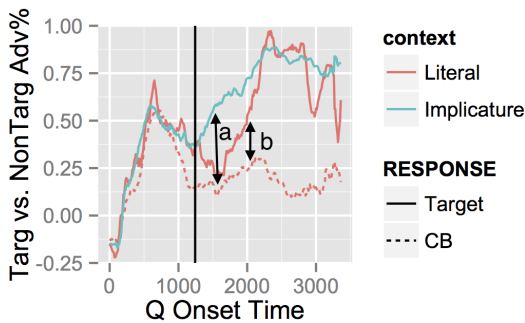
Figure 6: Target Advantage plot for **Global** trials, time-locked to the onset of the quantifier. The vertical black bar indicates the average onset of the final noun.
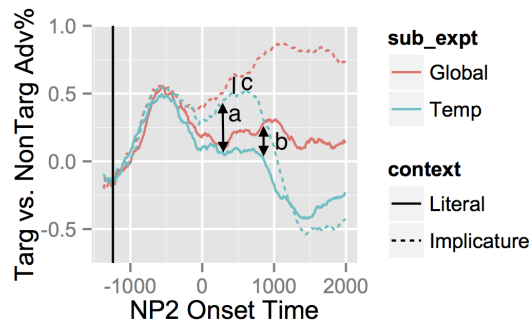
Figure 7: Target Advantage plot for Target (**Global**-∃-**Pic**) and CB choice trials (all others) by condition, time-locked to the final noun phrase. The vertical black bar indicates average onset of the quantifier.

phase of disfavoring the Target, compared to IMPLICATURE acceptance trials, and pattern together with LITERAL target rejection trials up until 2000ms after quantifier onset.

Turning to a comparison of the time course in GLOBAL and TEMP conditions with both LITERAL and IMPLICATURE picture versions, we find further evidence for implicature interpretations being at play even when this turns out to be innocuous for the final response. Focusing on trials where the covered box is chosen for the TEMP conditions as well as the LITERAL-GLOBAL condition (and on target selection trials for the IMPLICATURE-GLOBAL condition), Fig. 7 displays Target Advantage scores relative to the onset of the sentence-final noun. Interestingly, the IMPLICATURE-TEMP condition displays a sustained relative increase in looks to the target relative to the LITERAL-TEMP condition even after the onset of the noun (which, recall, does not match the accessory in the picture in the TEMP conditions (Fig. 7a). This is significant in 200ms time windows from 200-1000ms after the final noun (e.g., 200-400ms: $\beta = 4.39$, $SE = 0.99$, $t = 4.41$, $\chi^2 = 10.62$, $p < 0.1$). This suggests that the target is discarded relatively quickly based on the implicature interpretation in the LITERAL-TEMP condition, whereas it continues to be scrutinized for its relation to the sentence-final noun in the IMPLICATURE-TEMP

Furthermore, even in the LITERAL-GLOBAL trials that end in a covered box-choice, participants continue to look at the target much more than in LITERAL-TEMP trials from around 800ms after the onset of the final noun (Fig. 7b; 600-800ms: $\beta = 1.89$, $SE = 1.04$, $t = 1.82$, $\chi^2 = 2.78$, $p < 0.1$; 800-1000ms: $\beta = 3.93$, $SE = 0.97$, $t = 4.05$, $\chi^2 = 8.82$, $p < 0.01$). This suggests that even when the covered box is ultimately chosen based on an implicature interpretation, there is a lingering awareness of the potential viability of the LITERAL target picture version. The IMPLICATURE-GLOBAL and IMPLICATURE-TEMP fixation patterns come apart even earlier (Fig. 7c), at 400ms after the final noun ($\beta = 1.53$, $SE = 0.71$, $t = 2.16$, $\chi^2 = 4.15$, $p < 0.05$),

suggesting that the literal incompatibility of of the final noun phrase in the TEMP condition has an impact relatively quickly.

In sum, the path to target acceptance responses in the LITERAL-GLOBAL condition as reflected in fixation patterns differs from that in the IMPLICATURE-GLOBAL condition, in that there is a temporary decrease in looks to target in the latter. Furthermore, both IMPLICATURE-TEMP trials and LITERAL-GLOBAL trials display increased looks to the target, suggesting the active consideration of an implicature interpretation in the former and of a literal interpretation in the latter.

3.4. Discussion

This experiment combined two established psycholinguistic techniques (covered box and visual world) to create a novel paradigm for exploring the processing of scalar implicatures. It was designed to be a natural followup to Schwarz et al. (2015), and continue investigating the suggestion that the response time delays, traditionally attributed to scalar implicature computation, might instead be a result of participants' grappling with with the 'opposing pressures' pushing them towards different interpretations (literal and implicature) of the relevant sentences. If this opposing pressure hypothesis is on the right track, we would expect to see it revealed through a replication of Schwarz et al. (2015)'s response time patterns, as well as through eye-movement patterns that indicate participants are considering both interpretations in parallel at some point prior to responding.

3.4.1. Response Times

First, let us consider the predictions these theories make with regard to response times. The proposal that literal interpretations are considered first and implicature computation comes with a delay predicts increased response times for responses that require an implicature interpretation, relative to ones that are based only on a literal interpretation. The opposing pressures hypothesis, on the other hand, expects response-time delays to appear whenever participants are presented with a condition in which both the literal and implicature interpretations are in competition.

Looking to our response time results, we found that participants took longer to reject target pictures that were only consistent with the literal interpretation (LITERAL-GLOBAL), than to reject target pictures that were only temporarily consistent with the literal interpretation (LITERAL-TEMP). This pattern is consistent with the idea that implicature computation is delayed, as participants are taking longer to provide responses that require computation of an implicature (namely rejections in the LITERAL-GLOBAL condition), than to provide responses that could be based only on the literal meaning (rejecting LITERAL-TEMP). However, this pattern is also consistent with the opposing

pressures hypothesis, given that both literal and implicature interpretations remain live options in the LITERAL-GLOBAL condition right up until a choice is made between them by the participant, whereas in the LITERAL-TEMP condition the conflict is resolved once the final noun makes the target picture false according to both interpretations. Therefore, it seems that this difference in response times does not favor either explanation over the other.

We also found that participants took longer to select target pictures only consistent with the literal interpretation (LITERAL-GLOBAL), than to select target pictures also consistent with the implicature interpretation (IMPLICATURE-GLOBAL). This pattern is a replication of equivalent conditions from Romoli and Schwarz (2015) and Schwarz et al. (2015), and is more informative towards the aim of distinguishing between the two theories of interest, as the implicature delay hypothesis does not predict such a pattern. That is, we would expect at least some of the responses in the IMPLICATURE-GLOBAL condition to involve an implicature interpretation, while the target picture selections in the LITERAL-GLOBAL condition can only be based on a literal interpretation. Thus, according to the implicature delay hypothesis, the latter thus should be faster, if anything, but we find the opposite. In contrast, the opposing pressures hypothesis can account for this pattern straightforwardly, by noting that the LITERAL-GLOBAL condition forces participants to make a choice between the two possible interpretations, whereas, the IMPLICATURE-GLOBAL condition does not present such a conflict, with both the literal and implicature interpretations leading to selection of the target picture. Therefore, it seems that this pattern of response times is only consistent with the predictions of the opposing pressures hypothesis. (But see below for discussion of the possibility of a possible way to reconcile these results.)

Another important result was that we found rejections of pictures that were temporarily consistent with an implicature interpretation (IMPLICATURE-TEMP) to take longer than rejections of pictures that were temporarily only consistent with a literal interpretation (LITERAL-TEMP). This is a novel result, and seems to suggest that participants are more reluctant to abandon a target picture consistent with the implicature interpretation, than a target picture consistent only with the literal interpretation. This pattern is not predicted by either of the theories of interest, and so doesn't seem to be of use in their evaluation. However, it is notable that this pattern is consistent with an idea considered by Schwarz et al. (2015) (see also discussion by various previous authors, perhaps most prominently Levinson, 2000), that the implicature interpretation is the preferred/default interpretation of these sentences. After all, consideration of the implicature turns out to be entirely useless by the end of the sentences in this condition, and yet we find a strong impact of the implicature interpretation on behavioral response variables.

Finally, there was a block order effect in the present results, such that participants who had been presented with the GLOBAL trials first were faster in rejecting the target pictures in the LITERAL-TEMP condition. This suggests that consideration of trials where deciding on a response rides on deciding between an implicature and a literal interpretation has an effect on the processing of implicature interpretations in relation to literal ones later on in the experiment. More specifically, having had to decide between implicature and literal interpretations earlier on speeds up the de-

cision to respond based on an implicature later on in the TEMP conditions, prior to encountering the final noun which makes the literal meaning of the sentence incompatible with the picture in these conditions. This effect could be accounted for in different ways by the two approaches under consideration. From the perspective of the opposing pressures hypothesis, a way of capturing this priming effect would be to say that people become more practiced in making a decision between two available interpretations, and thus can make their judgment based on that decision more quickly in the TEMP conditions than if they had to wait until they can base their response on the final noun. The proposal that implicature computation induces a delay, on the other hand, could see this as a priming effect on the computation of an implicature interpretation, so that this interpretation becomes available more quickly after some practice. Note, however, that this practice effect must arise quite quickly, as there only is a total of 4 experimental trials where the response crucially depends on deciding between an implicature interpretation and a literal interpretation. The present response time data do not distinguish between these two options, but the effect should be of some interest for further study. Future work should also investigate whether there are comparable reflexes of such a priming effect in fixation patterns in the early phases of interpretation after encountering the quantifier.

In sum, it would appear that where the response time patterns distinguish between the two theories of interest, they seem to support the opposing pressures approach over the implicature delay theory. Notably, none of these results actually 'rule-out' the possibility that there is a delay in implicature computation, which is then further extended by the opposing pressures competition effect. However, without independent evidence showing that implicature computation is indeed contributing to the delay, considerations of parsimony lead us to prefer attributing the delay to opposing pressures explanation alone. We mention this because the eye tracking results that we turn to next will change the situation somewhat.

3.4.2. Eye tracking

First, as before, let us consider the relation of the theories under investigation to the eye movement results. On a simple two-stage version of the implicature delay theory, which assumes that there's an initial phase where only the literal interpretation is considered and a second phase where only the implicature interpretation is considered, participants' eye movements are expected to reflect these two stages: first, eye movements should be attracted to any pictures compatible with the literal interpretation, and subsequently, attention should be restricted to those compatible with the implicature interpretation. On the other hand, the opposing pressures approach would predict there to be a phase where participants' eye movements oscillate as the two interpretations are weighed against one another.

Considering trials ending in target picture selections in the IMPLICATURE-GLOBAL and LITERAL-GLOBAL conditions first, the latter exhibit a phase with a relative decrease in looks to the target,

despite being ultimately chosen. This is surprising on a two-stage account with a delay for implicatures, as literal responders would not be expected to go beyond the initial, literal phase in the first place. But if there is a phase where both interpretations are considered in parallel, as on the opposing pressures approach, this back and fourth in the LITERAL-GLOBAL condition is very much expected, regardless of what final interpretation is being adopted. And in fact, the results for trials in the LITERAL-GLOBAL condition ending in a covered box choice further support this point: relative to the LITERAL-TEMP condition, the proportion of looks to the target continues to be higher in the final trial-phase, suggesting that even when subjects respond based on the implicature interpretation, they continue to consider the literal interpretation as a potential alternative.

Another interesting aspect of the eye-tracking results was revealed when comparing the LITERAL-TEMP and IMPLICATURE-TEMP conditions. Given the mismatch of the mentioned noun and the accessory in the target picture, the ultimate choice here was the covered box. Nonetheless, we found a difference in fixation patterns, in that the IMPLICATURE-TEMP condition showed sustained looks to the target picture after the onset of the final noun. This pattern provides more insight into the relative delay participants displayed in their response times in the IMPLICATURE-TEMP condition, compared to the LITERAL-TEMP condition. In particular, it lends further support to the notion that the response time delay is due to the temporary compatibility of the picture with an implicature interpretation, as the picture gets scrutinized further for compatibility with the noun in the IMPLICATURE-TEMP condition, while it is abandoned more quickly in the LITERAL-TEMP condition, which can be rejected before hearing the noun if and only if an implicature interpretation is adopted. Thus, that interpretation seems to be adopted relatively quickly, before the sentence final noun comes in, consistent with the notion that implicature interpretations are preferred, and may even have the status of being the default choice.

What our eye movement clearly show, then, is that there is a phase where both implicature and literal interpretations are considered, and that responses based on literal interpretations generally do involve consideration of the implicature interpretation at some point. Furthermore, they suggest that implicature interpretations do constitute the default, in that they give rise to effects even when they ultimately turn out to be irrelevant, as in the TEMP conditions. Overall, this supports the interpretation of the response time results in Schwarz et al. (2015) in terms of opposing pressures favoring the respective interpretation options. They are clearly incompatible with the simple two-stage implicature delay model as outlined above. Note, however, that that is not say that they are altogether incompatible with the notion that implicature computation takes time. An alternative account could consider a three-stage variant, where an initial literal phase is followed by a phase where the implicature interpretation is considered along with the literal interpretation, which can be followed by a decision for the literal interpretation - in line with the notion of implicature cancellation posited by default accounts. In effect, this would combine the competition aspect of the opposing pressures approach with an initial implicature delay (and more generally, different aspects of Literal First and Default accounts). Indeed, one aspect of our data could well be seen as supporting a delay account, as we see a decrease in looks to the target in the LITERAL-GLOBAL condition at a time-point (1000-1200ms) that is comparable to the implicature-based looking pat-

tern found by Huang and Snedeker (2009). This decrease in looks to the target in the LITERAL-GLOBAL condition could be interpreted as being indicative of the point at which participants move from accessing the initial literal interpretation to the more costly implicature interpretation.

While this combination of an initial implicature delay and a competition phase is consistent with our data, it is in principle also possible to try to account for initial delay effects in terms of an emerging competition effect. In particular, it could be that it is not access to an implicature interpretation itself that is delayed, but rather the emergence of the preference for that interpretation. In effect, the opposing pressures account could posit a temporal asymmetry for the two pressures at play, with a charity-like preference for true interpretation being operative early on, and a preference for implicature interpretations arising later on. As far as we can tell, existing data does not clearly distinguish between these two possibilities.

4. Conclusion

In this paper, we use a novel paradigm combining Visual World eye-tracking with the Covered Box paradigm to investigate the time course of literal and implicature interpretations. In particular, we aimed at investigating the proposal by Schwarz et al. (2015) that the delays which arise with sentences involving scalar implicatures is at least in part due to a competition effect between different possible interpretations. The results suggest that there is a phase where both literal and implicature interpretations are available in parallel. Moreover they show that (at least in this paradigm) literal acceptances are only provided reluctantly, after consideration of an implicature interpretation, presumably due to a preference for implicature meanings, in line with Schwarz et al.'s proposal and more generally the notion that implicature interpretation constitute a default of sorts. They thus support the idea that there is a competition effect between the two potential interpretations, which is present for both literal acceptances and implicature-based rejections. In addition, the response time data display an implicature-based block-priming effect, suggesting that the resolution of this conflict can be sped up through repeated task-exposure.

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SINN UND BEDEUTUNG 20

NPI Intervention of *too*[1]

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Abstract. The additive focus particle *too* has an intervention effect on NPI licensing (Homer 2008, 2009). While Homer argues that it is the non-DE additive presupposition that intervenes, this analysis contrasts with generalizations that presuppositional components of licensers do not affect NPI licensing, especially weak NPIs like *anything* (von Fintel 1999, Chierchia 2004, Gajewski 2011, a.o.). By arguing that *too* asserts a conjunction between the host proposition and a propositional anaphor that refers to some salient antecedent, this paper provides an explanation of *too*'s intervention effect while maintaining the generalization made in Gajewski 2011 that only strong NPIs are sensitive to non-truth conditional meanings of their licensers. Noting that a fully parallel intervention effect is also found with an overt conjunction in English (Chierchia 2013), it is argued that the analysis provided for the overt conjunction can be applied directly to explain why *too*, a covert conjunction, intervenes with NPI licensing.

Keywords: NPI intervention, presupposition *too*.

1. Introduction

This paper is concerned with explaining the NPI intervention effect of the focus-sensitive additive particle *too*. The NPI intervention effect of *too* as well as the determiners *the* and *both* is discussed in Homer (2008, 2009) as exemplifying cases where a presuppositional component of licensers block Negative Polarity Items (NPI). This contrasts with both von Fintel's (1999) proposal that NPIs are licensed with respect to Strawson downward-entailing (SDE) contexts, and Gajewski 2011 and Chierchia's 2013 generalization that only strong NPIs are sensitive to non-truth conditional meaning of licensers. While an alternative explanation of the intervention effect of *the* and *both* has been suggested in order to maintain the generalizations on weak and strong NPIs (Gajewski 2011), the case with *too* remains a puzzle. This paper suggests that a conjunction account of *too* proposed in Ahn 2015 can provide a solution to this puzzle. Specifically, it is argued that the intervention effect of *too* is not due to the presuppositional component of *too* as Homer assumes, but instead due to the covert conjunction that is proposed to be part of the truth-conditional meaning of *too* under the conjunction analysis. This way of looking at the intervention effect of *too* allows us to a) maintain the generalizations on the strong/weak distinction in NPIs and their licensing requirements; and b) explain the puzzling contrast between *too* and *again* with respect to intervention effects for which neither Homer (2008) or Gajewski (2011) provides an explanation.

2. NPI Licensing

While it is generally assumed that NPIs are licensed in downward entailing (DE) contexts, the DE hypothesis is not without problems. Observing cases where NPIs are licensed in apparently non-DE conditions such as in the scope of *only* as shown in (1), von Fintel (1999) suggests that NPIs are licensed with respect to Strawson DE environments as defined in (2). The basic argument is that NPIs like *anything* are not sensitive to presuppositional components, and the DE-ness of an environment is revealed once the presuppositional component is factored out.

(1)   Only John ate anything.

      a.   Presupposes: John ate something. (UE)
      b.   Asserts: No one else ate anything. (DE)

(2)   Strawson Downward Entailment (SDE):
      A function f of type $\langle \sigma; t \rangle$ is SDE iff for all x, y of type σ such that $x \Rightarrow y$ and $\underline{f(x) \text{ is defined}}$:
      $f(y) \Rightarrow f(x)$

Another line of research examines different types of NPIs and how their licensing requirements vary (Gajewski 2011, Chierchia 2004, a.o.) Observing that weak NPIs such as *any* and *ever* have different licensing requirements than strong NPIs such as punctual *until* and additive *either*, Gajewski and Chierchia argue that the two types of NPIs differ on what meaning components of licensers they are sensitive to. Specifically, Gajewski (2011) proposes that while strong NPIs are sensitive to non-truth conditional meaning of licensers such as presuppositions and implicatures, weak NPIs are not.

2.1. NPI Intervention

Homer (2008, 2009) discusses cases where presuppositions of a licenser interfere with NPI licensing. First he notes that the restrictors of *the* and *both* do not allow NPIs in them, as shown below.

(3)   Context: There is exactly one student who read some books on NPIs.   [Homer 2008 (9)]

      a.   *The student who read any books on NPIs is selling them.
      b.   The student who read books on NPIs is selling them.
      c.   Presupposition of (3b) : There is exactly one student who read books on NPIs.

(4)   Context: Exactly two students read some linguistics books.   [Homer 2008 (11)]

a. *Both students who read any linguistics books have applied to the department.
b. Both students who read linguistics books have applied to the department.
c. Presupposition of (4b) : There are exactly two students who read linguistics books.

If NPIs are licensed with respect to Strawson DE environments as von Fintel (1999) argues, this NPI intervention effect is surprising. This is because, once the presuppositions in (3c) and (4c) are satisfied in the context, the determiners *the* and *both* are SDE with respect to their restrictors (Giannakidou 2004). Homer uses cases like (3) and (4) to argue that the presuppositions of *the* and *both* do indeed interfere with the licensing of *any*. However, as Gajewski (2011) notes, it is not clear why presuppositions of some licensers would have the intervention effect while others, like that of *only* does not.

Chierchia (2004) and Gajewski (2011) suggest an alternative explanation for the intervention effect of *the* and *both*. Noting that Homer's assumption that the truth-conditional meaning of *the* and *both* is strictly DE is not obvious, Gajewski suggests the possibility that the truth-conditional meaning of *the* and *both* may also contain existence. The suggested meanings are given below, with the existence component underlined.

(5) $[\![\textbf{both(A)(B)}]\!]$ is defined only if $|A|=2$.
        When defined, $[\![\textbf{both(A)(B)}]\!] = 1$ iff $\underline{A \neq \emptyset}$ & $A \subseteq B$.

(6) $[\![\textbf{the}_{\textbf{sg}}\textbf{(A)(B)}]\!]$ is defined only if $|A|=1$.
        When defined, $[\![\textbf{the}_{\textbf{sg}}\textbf{(A)(B)}]\!] = 1$ iff $\underline{A \neq \emptyset}$ & $A \subseteq B$.

If this were the case, Gajewski argues, there is no reason to believe that it is the presupposition that interferes with NPI licensing: the truth-conditional meaning of the determiners is already not adequate to license NPIs. Gajewski further notes that if it could be generalized that presuppositions of licensers never interfere with the licensing of weak NPIs, it would mirror the generalization made in Chierchia 2004 that implicatures of licensers never interfere with weak NPI licensing.

In addition to *the* and *both*, Homer discusses another set of data which suggests that the presuppositions of licensers can interfere with NPi licensing. Specifically, Homer observes that the focus sensitive additive particle *too* interferes with the licensing of *any*:

(7)   Context: Mary read some interesting book.   [Homer 2008 (17)]
        a. *I dont think [John]$_F$ read anything interesting too.
        b. I dont think [John]$_F$ read something interesting too.
        c. Presupposition of (7b): Somebody other than John read something interesting.

Gajewski does not discuss *too* further and leaves open the question of why *too* shows this intervention effect. In the next section, I elaborate on the intervention data with *too*. I also introduce the puzzle that neither Homer nor Gajewski solves: that the intervention effect only arises with *too* and not *again*, which is similar to *too* in the way its presupposition is analyzed.

3. NPI Intervention of *too*

Homer (2008, 2009) assumes that the truth-conditional meaning of *too* is DE, and thus argues that the additive presupposition of *too* is what blocks the licensing of *anything*. This is shown in (8), where the host proposition *John read anything interesting* is DE, but the antecedent proposition *Mary read something interesting* is UE. This upward-entailing presupposition is argued to be what blocks the NPI *anything* from being licensed.

(8)   Mary read something$_D$ interesting. $\land$ $\neg$[John read anything$_D$ interesting].
$\qquad\qquad\qquad$ $\Uparrow$ $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ $\Downarrow$
$\qquad$ Mary read something$'_D$ interesting. $\land$ $\neg$[John read anything$'_D$ interesting].

The infelicitous (7a) is contrasted to the grammatical (9a), where additive *either* does not show the same intervention effect as *too*:

(9)   Context: Mary didnt read anything interesting.
$\qquad$ a.   I dont think [John]$_F$ read anything interesting either.
$\qquad$ b.   Presupposition: Somebody other than John didnt read anything interesting.

Homer assumes that the only difference between *too* and *either* is the polarity in their presuppositions. While it is not specified in Homer what analysis of *too* he is taking, I give Rullmann's (2003) definitions of *too* and *either* for concreteness. Under Rullmann's analysis, *too* and *either* are identical except that *either* has a negative presupposition.

(10)   Semantics of *too*
$\qquad$ a.   Ordinary semantic value: $[\![p \textbf{ too}]\!]^o = [\![p]\!]^o$
$\qquad$ b.   Focus value: $[\![p \textbf{ too}]\!]^f = \{[\![p]\!]^o\}$
$\qquad$ c.   Presupposition: $[p$ too$]$ presupposes that there is at least one contextually salient proposition $q \in [\![p]\!]^f$ - $\{[\![p]\!]^o\}]\!]$ such that q is true.

(11)   Semantics of *either*
$\qquad$ a.   Ordinary semantic value: $[\![p \textbf{ either}]\!]^o = [\![p]\!]^o$
$\qquad$ b.   Focus value: $[\![p \textbf{ either}]\!]^f = \{[\![p]\!]^o\}$

     c.   Presupposition: [p either] presupposes that there is at least one contextually salient proposition $q \in [\![p]\!]^f - \{[\![p]\!]^o\}]$ such that q is false.

Homer argues that the intervention is not caused by the mere presence of a presupposition trigger between the NPI licenser and the NPI because *either*, which appears in the same position, does not have this effect. Furthermore, since the only difference between *too* and *either* is that *either* has a negative presupposition as shown above, it must be the non-DE presupposition of *too* that intervenes with the licensing of *anything* in (7a).

There are at least two issues that need to be addressed. The first is an empirical issue that one of the predictions made by this analysis does not seem to be borne out in contrast to Homer's claim. The second is the puzzling contrast between *too* and *again*, where *again* does not have the same NPI intervention effect. I discuss these two issues in turn.

3.1. NPI Inside the Focus of *too*

Homer assumes that the non-DE nature of the presupposition is what causes the NPI intervention of *too*. The presupposition of *too* is created by replacing the focused element in the host proposition with a focus alternative as shown in (10). This means that, if an NPI appears inside the focus of *too*, it will appear in a DE position in the presupposition. Thus, Homer's analysis predicts that if the NPI appears as or inside the focus of *too*, the intervention effect should disappear. Homer gives such examples given in (12) and argues that this prediction is borne out.

(12)   Context: Many students in Mary's class read a very interesting book.
        a.   I dont think [anybody in John's class]$_F$ read something interesting too.
        b.   Presupposition: Somebody other than anybody in John's class read something interesting.

However, this judgment is not shared with all speakers. Three English speakers who were asked to judge the sentence did not find *too* felicitous in contexts like (12). In fact, the speakers suggested that *either* is much better than *too* in this sentence, showing that the contrast between *too* and *either* remains. The suggested modification is shown in (13a), where *too* is replaced with *either*. Speakers also noted that *anything* can be used in place of *something* as well.

(13)   Some people in Mary's class read something interesting.
        a.   I dont think [anybody in Js class]$_F$ read something/anything interesting either.

3.2. Contrast with *again*

Another issue in Homer's analysis is the contrast with *again* that both Homer and Gajewski discuss. The contrast is that *again*, unlike *too*, does not show the same intervention effect in (14). This is surprising considering that the presupposed content is non-DE as much as the presupposition of *too* is assumed to be in Homer.

(14)   *I dont think [John]$_F$ read anything interesting, too.

(15)   a.   I dont think John [ate anything interesting] again.
         b.   Presupposition: John ate something interesting before.

So far, we have looked at examples where the licensing of the NPI *anything* seem to be blocked in contexts that were apparently DE. Homer introduces these arguments as cases that tell us that sometimes presuppositions of licensers can affect NPI. This contrasts with von Fintel's argument that presuppositions must be factored out when assessing the licensing conditions of NPIs, as well as Gajewski's generalization that only strong NPIs are sensitive to non-truth conditional components of the licensers. In order to reconcile this disparity, Gajewski seeks a way to analyze the meaning of licensers in a way that allows the truth-conditional component of the licensers to be non-DE. While this was done for *the* and *both*, the problem of *too* has not yet been solved. We then looked at some additional issues with Homer's claims about *too*: unlike the prediction made by Homer that NPIs appearing within the focus of *too* should be licensed, such sentences are not felicitous; and there is no clear way in Homer's analysis to account for the fact that *again*, which also has a non-DE presupposition, does not have the same intervention effect.

In the next section, I introduce an alternative way of analyzing the focus particle *too*. Taking Ahn's (2015) proposal, I argue that *too* asserts a conjunction between two propositions. After a brief discussion of how this is an innocuous modification of the traditional view of *too*, I go on to show that this way of analyzing *too* allows us to account for the two issues we find in Homer and to maintain the genearalization made in Gajewski 2011. It will be argued that the culprit of (7a)'s infelicitousness is not the additive presupposition of *too* that is non-DE. Instead, it is due to the covert conjunction that is assumed to be part of the asserted meaning of *too* under Ahn 2015. This parallels the argument made in Chierchia (2013) to explain a fully parallel case of intervention that is found with a conjunction but not with disjunction. Chierchia's explanation is extended to apply to both *too* and additive *either*, explaining the contrast that Homer observes.

4. Conjunction Analysis of *too*

I propose in Ahn 2015 that *too* asserts a conjunction between its host proposition and a propositional anaphor that refers to some antecedent.

(16) $[\![\mathbf{too}]\!](q)([\![\mathbf{p}]\!]_{\sim C}) = \lambda w: q \in C - \{[\![\mathbf{p}]\!]^o\}. \, q_w \wedge [\![\mathbf{p}]\!]^w$

Too takes as its argument the host proposition p and a propositional anaphor q that refers to some salient antecedent proposition. It is presupposed that the antecedent of q is an element of a contextually-determined C, which has as its members the focus alternatives of p. The assertion is a conjunction between q and p. Thus, given (17), the host proposition p is *John left*, and a propositional anaphor q looks for a salient antecedent of the form *X left*. The assertion is a conjunction between q and *John left*, which can be paraphrased as 'In addition to *that* (what q refers to), John left.' As shown in (17c), the antecedent proposition does not have to be a strict focus alternative of p in the form of 'X left': as long as it entails a focus alternative of p, it can serve as the antecedent.

(17)   John$_F$ left too.

      a.   Assertion: $q \wedge$ John left
      b.   C = {Bill left, someone left, Sue left, ...}
      c.   Possible antecedent: Bill left, Bill didn't stay, Most people left, ...

At first it may seem problematic that q is asserted as a conjunct rather than presupposed. *Too* is traditionally analyzed as only contributing a presuppositional component to the meaning of the host proposition (Heim 1992, Rullmann 2004, Cohen 2009, a.o.), and cases of presupposition projection displayed with sentences containing *too* as in (18) seem to support that the antecedent information is presupposed rather than asserted.

(18)   a.   Did John leave too?
      b.   If John left too, then Mary would be angry.
      c.   It is possible that John left too.
            $\rightarrow$ In all cases, the antecedent (*Bill left*) is "projected"

However, I argue that this is not problematic since what is asserted in the definition of *too* is not the antecedent proposition itself but an anaphor that refers to it. There is, for instance, a difference between actually asserting a proposition as in (19a) and having an anaphor as in (19b).

(19)   a.   If Bill left and John left, Mary would be angry.
      b.   If that AND John left, Mary would be angry.

Because the antecedent information must hold in order for the anaphor to be resolved, the result is indistinguishable from presupposition projection.

4.1. Disjunction Analysis of Additive *either*

Homer assumes that the only difference between *too* and additive *either* is the nature of the presupposition. While he does not specify the exact definition, his examples suggest that he is assuming an analysis in a similar line as Rullmann's, where the presupposition of additive *either* is negative. However, this kind of contrast cannot apply to the conjunction account of *too*: there is no positive presupposition that can be negated to capture the meaning of additive *either*. Instead, Ahn (2015) argues that additive *either* has to be analyzed as a disjunctive counterpart of *too*.

(20) $[\![\textbf{either}]\!](q)([\![\textbf{p}]\!]_{\sim C}) = \lambda w: q \in C - \{[\![\textbf{p}]\!]^o\}. \ q_w \vee [\![\textbf{p}]\!]^w$

This claim, motivated by additive *either*'s diachronic and synchronic relation to other disjunctive uses of *either*, is shown to allow a natural explanation of its NPI distribution. For example, because it asserts a disjunction, which is an existential, it fits the generaliztaion that existentials rather than univeresals tend to be polarity sensitive (Chierchia 2013). Also, assuming that additive *either* has the same scalar and domain alternatives as a regular disjunction, Ahn (2015) shows that there is a way to formally derive the NPI distribution under the exhaustification-based framework (Krifka 1995, Lahiri 1998, Chierchia 2006). While I refer the reader to Ahn's (2015) paper for more details on the definition of additive *either*, the analysis of *either* as a covert disjunction is mentioned here because it will become relevant in the next section where we discuss Chierchia's 2013 observation that conjunctions, but not disjunctions, show an NPI intervention effect.

5. NPI Intervention of Conjunction

Chierchia (2013) observes that conjunctions, but not disjunctions, intervene with NPI licensing.

(21) a. ??Theo didn't drink the leftover wine and any coffee.
      b. Theo didn't drink the leftover wine or any coffee.

In order to account for this, Chierchia uses notions of exhaustification, operator-based licensing of NPIs, and locality constraints. Basically, NPIs are assumed to obligatorily activate scalar and/or domain alternatives that are exhausted by an operator. Locality plays a role in that other alternative-carrying elements that appear in between the operator and the NPI must obligatorily be exhaustified. Using these notions, Chierchia shows that the implicature that results from a negated conjunction is what blocks the NPI. He argues that the implicatures associated with *and* must be computed before NPI due to locality constraints: as shown in (22), the scalar trigger *and* is structurally closer to the exhaustification site than the NPI.

(22)   O [¬[BoolP$_{[\sigma,D]}$ [T drink wine and$_{[\sigma,D]}$ T drink any$_{[\sigma,D]}$ coffee]]]

The resulting implicature is (23), and the disjunct *Theo drank any coffee*, which is underlined, is the culprit of the intervention effect: *any* is appearing inside a non-DE environment, and thus it is ruled out.

(23)   ??Theo didn't drink the leftover wine and any coffee.

    a.   Implies: ¬[Theo drank the leftover wine and (Theo drank) any coffee]
        = *Theo drank the leftover wine or Theo drank any coffee.

Chierchia further argues that there is no implicature that arises from the disjunction in (21b) because the negation of a disjoined pair of propositions is the strongest within the scalar alternatives. Thus, there is no intervention effect and *any* is licensed.

(24)   Theo didn't drink the leftover wine or any coffee.

    a.   Asserts: ¬[Theo drank the leftover wine] ∧ ¬[Theo drank any coffee].

6. Going Back to *too*

In the last section we saw that Chierchia's analysis of NPI licensing can be used to explain why conjunction but not disjunction intervenes with NPI licensing. Under the conjunction account of *too*, it is possible to extend Chierchia's argument directly to the contrast shown in *too* and *either*. Under the conjunction account, *too* is itself a covert conjunction. Thus, the resulting implicature has the same problem discussed in Chierchia 2013, that the disjunct containing *any* is not DE. On the other hand, this is not the case with additive *either*, because, similar to Chierchia's example with an overt disjunction, the resulting implicature still provides a DE environment for *any*. Thus, under the assumption that *too* is a covert conjunction, we get the intervention effect for free.

(25)   *I dont think John read anything interesting too.

    a.   ¬[q and John read anything interesting]
        = *q or John read anything interesting.

6.1. Contrast with *again*

The contrast with *again* is also no longer a puzzle. The contrast was only considered a puzzle to the extent that both *too* and *again* were analyzed as having the same type of additive presuppositions.

If the additive presupposition of *too* intervenes, it is surprising that the repetitive presupposition of *again* does not intervene. However, if *too* is an asserted conjunction, then the fact that *again* does not intervene can simply follow from Gajewski's generalization that *any* is still licensed because the non-DE presupposition does not play a role in licensing weak NPIs.

(26)   John cooked some good food yesterday. I don't think John cooked anything again today.

7. Conclusion

In this paper, I have shown that analyzing *too* as a covert conjunction coordinating a propositional anaphor and the host proposition can provide an alternative analysis of its NPI intervention effect (Homer 2008, 2009) in a way that is compatible with the generalization made in Chierchia 2004 and Gajewski 2011 that only strong NPIs are sensitive to non-truth conditional meaning of licensers. While there have been alternative explanations suggested for *the* and *both*, the intervention effect of *too*, especially the contrast with *again* which does not intervene, has remained a puzzle. By adopting a conjunction analysis that enables an explanation where the NPI is blocked solely due to the non-DEness of the asserted content, this paper strengthens Gajewski's generalization on how strong and weak NPIs differ in terms of their sensitivity to their licensing environments.

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Discourse Rationality and the Counterfactuality Implicature in Backtracking Conditionals[1]

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Abstract. This paper contributes to current discussions of counterfactuality implicatures in *would*-conditionals. The empirical focus is on the contrast between forward-looking and backtracking examples in Anderson-style 'detective reasoning' sequences. We show that differences regarding the cancellability of counterfactuality in these examples follow from general principles of discourse rationality and can be extended to provide a more general account of the cancellability of counterfactuality implicatures (e.g. in future-shifted examples).

Keywords: counterfactuality, implicatures, conditional perfection, backtracking counterfactuals.

1. Introduction

This paper investigates counterfactuality in *would*-conditionals bringing together ideas about counterfactuality implicatures, backtracking conditionals and good 'discourse manners'. The empirical focus will be on Anderson-style (Anderson 1951) cancellation of counterfactuality, comparing 'forward looking' conditionals with backtrackers (in which the consequent temporally precedes the antecedent). As (1) illustrates, counterfactuality appears cancellable in 'forward looking' conditionals (1a), but not so in backtrackers (1b):

(1)   a.   If Jones had taken arsenic yesterday, he would show lividity symptoms now. He does show lividity symptoms now. So he probably took arsenic yesterday.

       b.   If Jones were showing lividity symptoms now, he would (have to) have taken arsenic yesterday. He did take arsenic yesterday. # So he is probably showing lividity symptoms now.

The paper proposes an account of the contrast between (1a) and (1b), exploring its consequences for the cancellation of counterfactuality in other types of examples. An important component of our proposal is the idea that good discourse manners are expected: if a speaker has chosen to set up an implicature, it cannot be trivially cancelled (i.e. cancelled 'for no reason'). Conditional perfection will also be an important component of the account, as we will show that it plays an important role in the cancellation of implicatures via the detective reasoning associated with Anderson-style examples. With these ingredients in place, our account of why counterfactuality cannot be can-

celled in examples like (1b) will also be able to account for the observed difficulties in cancelling counterfactuality in future-shifted *would*-conditionals (as discussed by e.g. Ogihara 2000; Ippolito 2013).

The paper is structured as follows: in *Section 2* we spell out our assumptions about counterfactuality, expanding on the proposal in Leahy (2011) to characterize it as an antipresupposition while at the same time noting the problem for cancelling counterfactuality in non-standard *would*-conditionals presented in Biezma et al. (2013); in *Section 3* we discuss backtracking *would*-conditionals, following Arregui (2005a, b), in *Section 4* we spell out our assumptions about conditional perfection, building on von Fintel (2001, 2009) to include a discussion of perfection in backtrackers; in *Section 5* we spell out the proposal for the cancellation of counterfactuality in forward-looking vs. backtracking *would*-conditionals, and extend our proposal to argue that nothing special needs to be said about future-shifted *would*-conditionals (contra Ippolito 2013, Martin 2015); we conclude in *Section 6*.

2. On counterfactuality

2.1. Cancelling counterfactuality

As is standardly observed, an utterance of a *would*-conditional often gives rise to the understanding that the antecedent clause proposition is false in the actual world. We will use the term 'counterfactuality' informally to refer to this understanding. An illustration of counterfactuality is provided by (2) (an utterance of the conditional would most likely, out of the blue, lead to the understanding that Caspar did not come to the party):

(2)   If Caspar had come to the party, it would have been fun.   (Lewis 1973)

Ever since Anderson (1951), it has been accepted that counterfactuality in *would*-conditionals is an implicature. The slight variant of Anderson's famous example provided in (1a) is repeated below:[2]

(3)   If Jones had taken arsenic yesterday, he would show lividity symptoms now. He does show lividity symptoms now. So he probably took arsenic yesterday.

Counterfactuality is 'cancelled' in (3) (as had been noted by Anderson already, the discourse in (3) actually argues in favour of the truth of the antecedent).

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[2]Here is Anderson's original example:

(1)   In the investigation of Jones's death, a doctor might say, "If Jones had taken arsenic, he would have shown just exactly those symptoms which he does in fact show". Now in this context the doctor's statement would probably be taken as lending support to the view that Jones took arsenic - it would certainly not be held to imply that Jones did not take arsenic.   (Anderson 1951: 37)

Examples like this support the view that counterfactuality is not actually part of the truth-conditional content of *would*-conditionals or a presupposition, but arises instead as a defeasible pragmatic inference.[3] Anderson-type examples had already been given by Chisholm (1946), who described the 'deliberative use' of *would*-conditionals (that he termed 'subjunctives') as 'detective reasoning':

(4)   When we prepare for a crucial experiment, we review the situation and consider what would happen if our hypothesis were true and what would happen if it were false. The subjunctive conditional is essential to the expression of these deliberations. In defending a hypothesis, I may employ a subjunctive conditional even though I believe the antecedent to be true; I may say, "If this were so, that would be so; but, as you see, this *is so*....". It is said that detectives talk in this manner.   (Chisholm 1946: 291)

Additional support for the claim that counterfactuality is not presupposed comes from Stalnaker's observation that at times we seem to meaningfully argue in favour of the falsehood of the antecedent, a move predicted to be trivial if counterfactuality were presupposed:

(5)   Consider the argument, 'The murdered used an ice pick. But if the butler had done it, he wouldn't have used an ice-pick'. So the murderer must have been someone else. The subjunctive conditional premise in this modus tollens argument cannot be counterfactual since if it were the speaker would be blatantly begging the question by presupposing, in giving his argument, that his conclusion was true.   (Stalnaker 1975: 277)

But it should be said that counterfactuality is insistent. Lewis (1973) claimed that, upon finding out that the antecedent of a *would*-conditional is true, we are more likely to come to believe that the conditional was false rather than to accept that the consequent is true. So, if after hearing somebody utter (2) we were to find out that Caspar did go to the party, we would be more likely to conclude that the speaker of (2) had said something false rather than conclude that the party was indeed fun. In Lewis's words, *The false information conveyed by using a counterfactual construction with a true antecedent eclipses the falsity or truth of the conditional itself.* (Lewis 1973: 26). The fact that it is not trivial to set aside counterfactuality is an important lesson, and we will come back to this in the following sections. Cross-speaker dialogues, as Lewis noted, can help provide suitable settings for side-stepping counterfactuality without generating weird discourses:

(6)   A: If Caspar had come, it would have been a good party.
       B: That is true; for he did, and it was a good party. You didn't see him because you spent the whole time in the kitchen, missing all the fun.   (Lewis 1973)

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[3]In following sections we will schematize the truth-conditional content of *would*-conditionals as $\alpha \Rightarrow \beta$ and the counterfactuality implicature as $\rightsquigarrow \neg\alpha$.

As (6) illustrates, two speakers may agree on a *would*-conditional without agreeing on the truth/falsity of the antecedent, again supporting the view that counterfactuality is not presupposed.

While there is broad agreement that counterfactuality in *would*-conditionals is an implicature, examples in which it is impossible/difficult to cancel (such as (1b)) present a challenge. As we will show, the explanation for the difficulties in (1b) can actually account for a family of examples.

2.2. The counterfactuality implicature

There are various views regarding how the counterfactuality implicature is generated. Stalnaker (1975) suggested that the morphology typical of *would*-conditionals served as a 'conventional device' to indicate that presuppositions are being suspended (more recent proposals include von Fintel 1997; Iatridou 2000; Ippolito 2013). We will build on Leahy (2011), who elaborates an account of counterfactuality as an 'anti-presupposition' implicature arising from competition with indicatives. According to Leahy, indicative conditionals like (7a) presuppose that the antecedents are epistemically possible for their speakers, whereas conditionals like (7b) do not carry presuppositions. At the core of Leahy's proposal is the idea that when a speaker chooses to make an utterance that is presuppositionally weaker to a salient alternative with the same semantic content, s/he gives riese to the implicature that s/he does not believe the stronger presupposition to be felicitous (see Heim 1991 and related work in antipresuppositions). This accounts for the contrast between (7a), with counterfactuality implicature, and (7b), without:

(7)   a. If John had come, it would have been fun.
      b. If John came, it was fun.   (Leahy 2011)

We will add to the discussion of anti-presuppositions the contrast arising between examples with perfective (8a) vs perfect aspect (8b), investigated in Arregui (2005b, 2007):[4]

(8)   a. If your plants died tomorrow, I would be very upset.
      b. If your plants had died tomorrow, I would have been very upset.   (Arregui 2007)

Consider the examples against the following background: You will be away from your house tomorrow and ask me to look after your plants. I am worried, as I am very bad with plants. In this context, I could felicitously utter (8a), but (8b) would be odd. Suppose now that your plants died yesterday, and you let me know to cancel your request. In this context, I could felicitously utter (8b), but (8a) would be odd. As the second scenario illustrates, when it is known that the proposition that your plants die tomorrow is false (in this case, because it is known that they have already

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[4]It is left for future work to evaluate whether aspect-based competition could provide an account of all cases.

died), perfect morphology is required in the antecedent clause. The perfective morphology in (8a) restricts the domain of quantification to worlds compatible with what is known and does not allow us to quantify over worlds in which your plants die tomorrow instead of yesterday (resulting in a hypothesis that your plants die for a second time). Lewis (1973) had already noted the indicative-like flavour of *would*-conditionals like (8a) and set them aside in his account of counterfactuals:

(9)   More importantly, there are subjunctive conditionals pertaining to the future, like 'If our ground troops entered Laos next year, there would be trouble' that appear to have the truth conditions of indicative conditionals, rather than of the counterfactual conditionals I shall be considering.   (Lewis 1973: 4)

We will follow Arregui (2005b, 2007) in attributing the contrast between (8a) and (8b) to a view according to which perfective aspect carries epistemic consequences restricting quantification to worlds in the context set (see Arregui (2005b, 2007) for a detailed analysis, see Ippolito (2013) for critical comments). A consequence of this view is that perfect examples will lead to counterfactuality by competion with perfective examples. Counterfactuality in future-shifted examples like (8b) can thus be understood as an implicature arising from competition with examples like (8a). (The cancellation of counterfactuality in future-shifted examples has been investigated in e.g. Ippolito (2013) and Martin (2015), and we will return to this topic in Section 5.3).

2.3. Cancelling counterfactuality and discourse manners

The characterization of counterfactuality as an implicature in principle predicts that it can be cancelled. This does not, of course, predict that it will be trivial to cancel the implicature. Biezma et al. (2013) investigated another kind of *would*-conditional is which counterfactuality resisted cancellation, studying the contrast between the interpretation of 'regular' *would*-conditionals (10a) vs. non-standard forms (10b) below:

(10)   a. If Jones had taken arsenic, he would have shown some symptoms.
       b. If Jones would have/ had have/ would've/ had've/ woulda'/ hada'/ would of / had of taken arsenic, he would have shown some symptoms.   (Biezma et al. 2013)

Examples like (10b) had been discussed by Siddiqi and Carnie (2012), who developed morphosyntactic arguments showing that the extra morphology corresponds to modal heads.[5] Biezma et al. (2013) present the novel observation that in dialects that allow both (10a) and (10b), they do not actually obtain identical interpretation, since counterfactuality cannot be cancelled in the non-standard variants:

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[5]Contra the assumptions made in Ippolito (2013) and Martin (2015) that these are past markers.

(11)   a. If Jones had taken arsenic, he would have shown exactly those symptoms that he in fact shows (so, he probably took arsenic)

       b. # If Jones had've/ would've taken arsenic, he would have shown exactly those symptoms that he in fact shows (so, he probably took arsenic)

Biezma et al. (2013) provide a semantic analysis of the extra layer of modality in non-standard forms according to which the antecedent clause embeds a simple subjunctive. Adopting the proposal for simple subjunctives in Kasper (1992), they argue that non-standard forms make claims about the preconditions for the truth of the antecedent, and are informationally weaker than their standard counterparts. The proposal predicts that the utterance of a non-standard form gives rise to the implicature that the pre-conditions for the truth of the antecedent proposition are not satisfied, and thus also to the implicature that the antecedent proposition is false. Cancelling the implicature that the antecedent is false automatically cancels the implicature that the preconditions are not satisfied, but gives rise to the question of why the speaker chose the more complex form in the first place. The non-standard forms are morphologically, structurally, semantically and inferentially more complex. Their use is only (pragmatically) justified if some mileage will be obtained from this complexity. Cancelling the counterfactuality implicature in examples like (11b) would annul any advantage conferred by the more complex non-standard forms and work against 'discourse rationality' (cancelling an inference for no reason that one has chosen to trigger amounts to a 'discourse contradiction'). It would go against principles of pragmatic economy within the Gricean tradition (i.e. to use the simplest and most informative form available). In brief, this is 'bad discourse manners' and we are not willing to go along with it.

This account of why counterfactuality cannot be cancelled in non-standard *would*-conditionals like (10b) is reminiscent of proposals put forward by Abbott (2006) regarding why some presuppositions cannot be 'lifted' (cancelled). Abbott claims that it is not possible to cancel presuppositions associated with 'hard' presupposition triggers (i.e. those for which there is no reason for use other than to trigger a presupposition). We illustrate this in (12) with a cleft construction, which has been characterized as a hard trigger. As (12) shows, the associated presuppositions cannot be lifted:

(12)   I have no idea whether the problem has been solved, but # maybe it was Sue who solved it.   (Abbott 2006)

There is no reason to choose the more complex form other than to generate the associated presupposition. In this kind of cases, we do not accept efforts to cancel or detach the presupposition (as we do in some examples with 'soft' triggers). Underlying this explanation is the assumption that discourse participants will behave 'reasonably' and not wilfully choose specialized more-complex forms in order to lift the associated meanings for no reason whatsoever.

In agreement with this line of thinking, we consider that counterfactuality in *would*-conditionals in general cannot be cancelled 'for no reason'. Doing so would be a case of bad discourse manners. This corresponds with Lewis's early observation about the difficulties we face when evaluating a

would-conditional with true antecedents that we noted in Section 2.1. Our account of the asymmetry between (1a) and (1b) shows that whereas we have 'good reasons' to cancel counterfactuality in examples like (1a), this is not the case in (1b). And, as a result, we are not able to do so.

3. Double-modality in backtrackers

3.1. On backtracking and the semantics of *would*-conditionals

In the case of backtracking *would*-conditionals, the temporal location of the antecedent follows that of the consequent (we 'backtrack' in time as we move from antecedent to consequent). Backtracking *would*-conditionals have been the subject of much interest, both in the philosophical and, more recently, in the linguistics literature (e.g. Slote 1978; Davis 1979; Bennett 1984, 2003; Frank 1996; Arregui 2005a, b; Schulz 2007). Backtrackers appear to pose a problem for a Lewis-style resolution of similarity in the classic semantics for counterfactuals, and were already investigated in Lewis (1979). Lewis offered the following example:

(13)   Jim and Jack quarreled yesterday, and Jack is still hopping mad. We conclude that if Jim asked Jack for help today, Jack would not help him. But wait: Jim is a prideful fellow. He never would ask for help after such a quarrel; if Jim were to ask Jack for help today, there would have to have been no quarrel yesterday.   (Lewis 1979: 456)

Given the standard resolution of the similarity relation relevant for the interpretation of counterfactuals (Lewis 1973, 1979), backtracking conditionals like *If Jim were to ask Jack for help today, there would have to have been no quarrel yesterday* in (13) are expected to be false. The standard resolution of similarity identifies the domain of quantification as the worlds most similar to the actual world up to the time of the antecedent clause. In the example above, the time at which Jim asks Jack for help today. But in such worlds, there was a quarrel yesterday, so the consequent would be false. However, as Lewis pointed out, even though we often judge backtrackers as false, this is not always so. In some cases, in particular with an extra layer of auxiliaries as in (13) (*would have to have been*), backtrackers are quite easily judged as true.[6] Lewis did not see this as a problem for his analysis of counterfactuals, as it reflected a special resolution of the similarity relation. The kind of counterfactual dependence that interested him, associated with causation, arose only under the standard resolution of similarity that predicted that backtrackers were false. In what follows we analyze the 'special syntax' noted by Lewis as introducing a second layer of modality.

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[6]Our goal in this paper is to evaluate the backtracking version of Anderson-type examples, which are facilitated by the 'special syntax' noted by Lewis. We will thus limit our discussion of backtrackers to examples with special syntax. However, as has been noted in the literature (e.g. Arregui 2005a, b; Schulz 2007) some backtrackers go through quite smoothly without special syntax. We will mention them briefly in Section 5.

3.2. Double modality in backtrackers

As noted originally in Lewis (1979), backtracking in *would*-conditionals is often facilitated by a 'special syntax' with an extra layer of auxiliaries. Additional examples are provided below:

(14)   a. If the plane had arrived at 2:00, it would have to have departed at 1:00.   (Davis 1979)
        b. If the die had fallen six uppermost, it would (have to) have been thrown differently. (Bennett 1984)

In investigating the role of the special syntax, Davis (1979) argued that it introduced a second layer of modality that entailed that the consequent was true at the evaluation world (Davis characterized the consequent in (14a) as '*some sort of tensed modal statement*'). While the view that the consequent proposition is true at the evaluation world has proven problematic (see e.g. discussion in Bennett 2003), we will side with Davis in characterizing the consequent in examples like (14a) and (14b) as carrying an extra layer of modality with a structure that can be schematized as $\alpha \Rightarrow \Box\beta$ (see Arregui 2005a, b). The extra layer of modality in the consequent facilitates backtracking by invoking a non-reflexive modal accessibility relation. It may be marked overtly or it may remain implicit (as long as there is sufficient contextual support to allow it to be recovered). Consider Lewis's example again:

(15)   If Jim had asked Jack for help today, there would have to have been no quarrel yesterday.

With a second layer of auxiliaries in the consequent clause, the claim made by the conditional is about what the (salient) laws would have predicted under the circumstances described by the antecedent (where by 'laws' we understand natural laws, but also things like the conventions governing games, regulations and accepted (defeasible) generalizations regarding what is 'normal' or expected). In (15), the antecedent brings us to the most similar worlds in which Jim asked Jack for help today (in those worlds there was a quarrel yesterday), while the consequent requires that all such worlds be worlds in which the salient laws (let's say, generalizations regarding what is normal/habitual behaviour) require that there was no quarrel yesterday. The conditional may well be true without modifying the standard resolution of similarity in counterfactuals.
In summary, following Arregui (2005a, b), backtracking counterfactuals with special syntax claim that in the most similar worlds in which the antecedent is true, the worlds made accessible by (salient) law/s or generalizations are worlds in which the consequent is true (see details in Arregui 2005a, b). It is important to note two points about this proposal: (i) backtracking examples do not establish 'causal links' between antecedent and consequent (at least as intuitively understood); (ii) the second layer of modality in the consequent may appeal to a non-reflexive accessibility relation, which means that examples like $\alpha \Rightarrow \Box\beta$ may be true even if β is not true in the most similar worlds in which α is true. As noted, it is for this reason that the extra layer of modality facilitates

backtracking.

Examples with disagreement provide indirect support for the view that the consequents of back-trackers like (14a) and (14b) bear an extra layer of modality, even if it remains implicit.

(16)   A: If Jim had asked Jack for help today, there would (have to) have been no quarrel yester-
       day.
       B: That's not true. The other day Jim asked Jack for help after a quarrel.

As B's reply shows, accepting the truth of A's statement requires accepting the law-like general-ization that Jim does not ask Jack for help after a quarrel (contrast this with a disagreement along the lines: *That's not true. There would (still) have been a quarrel yesterday!*).

The discussion of backtracking *would*-conditionals is important because it shows that when we backtrack Anderson-style detective reasoning sequences, the results are importantly different from the original. The type of 'causal reasoning' associated with the 'forward looking' examples is broken, and a second layer of modality appears. These features of the backtracking examples will play an important role in explaining why counterfactuality cannot be cancelled in these cases.

4. Conditional strengthening in forward looking vs. backtracking *would*-conditionals

In a standard semantics for conditionals, abstracting away from specific conditional flavours, a conditional of the form *if p, q* claims that all relevant p-situations are also q-situations (e.g. in the case of *would*-conditionals, under a standard Lewis-Stalnaker style analysis, that all the most similar worlds in which the antecedent is true are also worlds in which the consequent is true). If a conditional is true, p will provide sufficient conditions for q. But, as noted already by Geis and Zwicky (1971), conditionals are often understood in a stronger manner, with the antecedent considered to provide sufficient and necessary conditions for the consequent. Here is one of their examples:

(17)   If you mow the lawn, I'll give you five dollars.

We naturally understand not only that I will give you five dollars if you mow the lawn, but also that I will only give you five dollars if you mow the lawn. This strengthened interpretation ('perfected') is not predicted by the standard semantics.

In his account of conditional perfection, von Fintel (2001, 2009) argued that strengthening in a conditonal *if p, q* is an implicature triggered when the conditional is considered to provide an exhaustive answer to the question of how to bring about the consequent q. The intuition, which von Fintel noted already in Cornulier (1983), is the following: conditional perfection arises in utterance situations in which it is understood that if conditions other than the antecedent (that is, sufficient conditions other than p) existed for the consequent q, they would have been mentioned. The fact that they haven't leads to the inference that the antecedent p provides the 'only' condi-tions (sufficient and necessary) leading to the consequent q. von Fintel's proposals puts together

a view according to which conditionals answer questions under discussion (QUDs) in the discourse situation (which may be implicit) (Roberts 2012; Büring 2003)) together with an account of questions-answer relations that allows answers to be understood exhaustively. Thus, when the QUD is understood to be a question about the conditions for the consequent and the antecedent is understood as an exhaustive answer, the result is a perfection of the interpretation to an 'if and only if' meaning. Consider the example below:

(18)   QUD$_{(implicit)}$: Under which conditions will you give me five dollars?
        If you mow the lawn, I'll give you five dollars.

As von Fintel points out, this proposal predicts a typology of cases in which perfection does arise and cases in which it does not. If a conditional is not understood as an answer to a QUD regarding the conditions for the consequent, the prediction is that perfection will not arise. Von Fintel illustrates this with an example of a conditional understood as a response to a QUD regarding what follows from the antecedent:

(19)   A: John is in Amherst today.
        QUD$_{(implicit)}$: What (of current interest) follows from John's being in Amherst today?
        B: If he is in Amherst, he'll be home late tonight.   (von Fintel 2001)

In examples like (19), in which the QUD is about the consequences, we do not expect a perfected interpretation and, as von Fintel notes, we do not obtain it. Another kind of example in which the proposal predicts absence of a perfected interpretation is in those cases in which a conditional is understood as responding to a QUD regarding the conditions for the consequent but in which the question is not understood as requiring an exhaustive answer, receiving instead a 'mention some' interpretation. Von Fintel suggests that 'mention some' interpretation for questions may contribute towards explaining contexts in which conditionals fail to receive a perfected reading. Consider the following type of example, discussed in von Fintel (2001) following an observation in Lilje (1972):

(20)   Teenager: How can I earn five dollars?
        Grandmother: I'll give you five dollars if you mow the lawn.

In cases like this, it is clear that the question does not require an exhaustive answer, and that mentioning one way of bringing about the consequent may be enough. The QUD seems to receive a 'mention some' interpretation and perfection is not predicted nor obtained.

We find perfected interpretations in the domains of *would*-conditionals in those cases in which we understand the conditional to address a QUD regarding what would have brought about the consequent (paraphrasing von Fintel 2001, *what are all the antecedents p such that in all p-worlds the consequent q would have been true?*).

(21)   QUD$_{(implicit)}$: In what circumstances would you have given me five dollars?
       If you had mown the lawn, I would have given you five dollars.

Below are further examples that can easily be understood as receiving a perfected interpretation:

(22)   a. Doctor scolding a patient for not taking medication on time: If you had taken your
           medication on time, you would have gotten better.
       b. Sports commentator evaluating an accident on a racing course: If Jones hadn't tried to
           overtake Smith, that crash would not have happened.

In spite of general pragmatic differences between *would*-conditionals and indicatives such as (17),
it is clear that the conditional interpretation is perfected in (22a)-(22b). The doctor's statement in
(22a) is naturally understood as indicating that it was only by taking the medication on time that
the patient would have gotten better. And the sports commentator in (22b) is noting that it is only
by failing to try to overtake Smith that Jones would have avoided the crash. We will follow von
Fintel in the view that perfection in these cases results from understanding the conditional as an
exhaustive answer to an (implicit) QUD (e.g. *what would you have had to do in order to get better?*,
under what circumstances would the crash have been avoided?). A perfected interpretation is
naturally understood for our original *would*-conditional examples in (1a), repeated below :

(23)   Doctor: If Jones had taken arsenic yesterday, he would have shown lividity symptoms
       today.

A doctor's utterance of (23) would lead us to conclude that if Jones had not taken arsenic yes-
terday, he would not have shown lividity symptoms today (without the poison, he would have
been symptom-free). The antecedent is thus naturally taken to provide not only sufficient but also
necessary conditions for the consequent. As expected given von Fintel's proposal, if the QUD is
not about what would have brought about lividity symptoms, but about the effects of arsenic, the
perfected interpretation does not arise. This is illustrated in the context set up in (24):

(24)   Doctor: Arsenic works like all the other poisons. If he had taken arsenic yesterday, he
       would have shown lividity symptoms today, just as if he had taken cyanide or curare.

The counterfactual in (24) does not lead us to conclude that it is only if he had taken arsenic yes-
terday that he would have shown lividity symptoms today.
In the proposed account, the possibility of generating a perfected interpretation for a conditional
depends on the conditional being understood as an exhaustive answer to an (implicit) QUD regard-
ing the conditions for the consequent. If a conditional cannot be understood as an answer to how a
consequent would have been brought about, it will not generate a perfected interpretation. This, we

claim, is an important difference between forward-looking *would*-conditionals and backtrackers. Contrary to what we have seen with forward-looking *would*-conditionals, backtrackers cannot be understood as answering a question regarding how the consequent would have been brought about. This is illustrated below with examples with the special syntax that facilitates backtracking:

(25)   a.   QUD$_{(implicit)}$: In what circumstances would the plane have to have departed at 1:00?
            # If the plane had arrived at 2:00, it would have to have departed at 1:00.

       b.   QUD$_{(implicit)}$: In what circumstances would the die have to have been thrown differently?
            # If the die had fallen six uppermost, it would have to have been thrown differently.

The discourses in (25a) and (25b) do not make coherent question-answer pairs. We cannot understand the backtrackers as providing an answer to a question about the circumstances that would have brought about the (modalized) consequent.[7] We can see this with our other examples:

(26)   a.   QUD$_{(implicit)}$: In what circumstances would there have to have been no quarrel yesterday?
            # If Jim had asked Jack for help today, there would have to have been no quarrel yesterday.

       b.   QUD$_{(implicit)}$: In what circumstances would it have been the case that Jones would have to have taken arsenic yesterday?
            # If Jones had shown lividity symptoms today, he would have to have taken arsenic yesterday.

We again see that the discourses with backtrackers do not provide natural question-answer pairs to QUDs about the conditions for the (modalized) consequent. Since the conditionals cannot be understood as providing an exhaustive answer to a question regarding the conditions for the consequent, the prediction is that perfection will not arise. As we will see in the next section, perfection is an important ingredient in the felicitous cancellation of counterfactuality. Differences in perfection will lie at the heart of the contrast between (1a) and (1b).

5. Cancelling counterfactuality

We are now in a position to address the contrast between (1a) and (1b). We have assembled our main ingredients: (i) counterfactuality in *would*-conditionals is an implicature that cannot be cancelled trivially ('for no reason') (from Section 2); (ii) backtracking *would*-conditionals are special (from Section 3); and (iii) forward-looking conditionals and backtrackers differ in terms of perfection implicatures (from Section 4). With these in hand, we will be able to explain (1a) vs.

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[7]We do not have an account of why this should be so. We could speculate that the QUD is understood as a question about 'causes', and backtrackers do not provide information about causes, but further work is needed.

(1b) and, as we will see, shed some light on counterfactuality in future-shifted *would*-conditionals more generally.

5.1. In forward-looking *would*-conditionals

Let us examine again the Anderson example:

(27)   Doctor: If Jones had taken arsenic yesterday, he would have shown lividity symptoms today. He does show lividity symptoms today. So he probably took arsenic yesterday.

What is the information provided by the *would*-conditional in (27)? In addition to the information provided by the truth-conditions of the conditional (28i), the interpretation is enriched with two implicatures: the counterfactuality implicature (28ii), and the perfection implicature that only if the antecedent is true will the consequent be true (28iii). Given this information, the utterance of the conditional leads to the inference that the consequent is false (28iv) (that is, $\rightsquigarrow \neg\beta$). But then the speaker in (27) continues by asserting the consequent (β). This must lead to a revision of the previous step and there are two options available: cancelling counterfactuality or cancelling perfection.

$$
(28) \quad \left[\begin{bmatrix} \text{i. } \alpha \Rightarrow \beta \\ \text{ii. } \rightsquigarrow \neg\alpha \\ \text{iii. } \rightsquigarrow \text{only if } \alpha \Rightarrow \beta \end{bmatrix} \text{iv. } \rightsquigarrow \neg\beta \right] +\beta \text{ hence } \left\{ \begin{array}{l} \text{cancel } \rightsquigarrow \neg\alpha \\ \textit{or} \\ \text{cancel } \rightsquigarrow \text{only if } \alpha \Rightarrow \beta \end{array} \right\}
$$

The assertion that Jones <u>probably</u> took arsenic yesterday reflects this dilemma. The speaker does not simply reject counterfactuality, aware of the possibility that perfection may be at fault (there may have been independent conditions that would have lead up to the consequent).[8] It is important to highlight that counterfactuality in this case has not been cancelled in a trivial manner, 'for no reason': given perfection, counterfactuality leads to a contradiction.

In the above discussion we have made the assumption that the utterance of the conditionals triggers conditional perfection. This is a crucial component of our account of why it is possible to cancel counterfactuality. The reason why following the conditional in (27) with the consequent (β) requires revision (and eventually leads to cancelling counterfactuality) is because of the interaction between conditional perfection and counterfactuality. The prediction is that if perfection is missing, Anderson-style sequences of 'detective reasoning' would not be felicitous. This is borne

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[8]Superficially, there seems to be an asymmetry between the two implicatures, in that we consider it probable that counterfactuality is false, as opposed to considering it probable that perfection was at fault. An investigation of preferences in this domain remains for future work.

out by the data. If, for example, as illustrated in (29), world knowledge weakens the perfection implicature, it becomes much tricker to cancel counterfactuality:

(29) Doctor: If Jones had taken arsenic yesterday, he would have high blood pressure now. He does have high blood pressure now. # So he probably took arsenic yesterday.

It would probably be odd for a doctor to utter (29). It is well-known (and salient) that high blood pressure may result from many different conditions. We do not (obviously) understand the conditional in (29) as perfected, and cancelling counterfactuality is not straightforward. Similarly, if we overtly set up a context in which it is clear that perfection will not be an option, counterfactuality is again difficult to cancel:

(30) Doctor: All poisons work the same. If he had taken arsenic yesterday, he would have shown lividity symptoms today, just as if he had taken cyanide or curare. He is actually showing lividity symptoms today. # So he probably took arsenic.

Contrary to what we saw in (27), the discourse in (30) is not obviously coherent. In the absence of perfection, the truth of the consequent is not informative with respect to the status of the antecedent. It does not lead to a revision of the counterfactuality implicature (since, in the absence of perfection, it does not generate contradictions).

5.2. In backtracking *would*-conditionals

We turn now to the backtracking Anderson example, repeated below:

(31) If Jones had shown lividity symptoms today, he would have to have taken arsenic yesterday. He did take arsenic yesterday, # so he probably shows lividity symptoms today.

As noted before, perfection is absent in backtracking examples. This means that the conditional will not give rise to the strengthening inference ($\leadsto$ only if $\alpha \Rightarrow \beta$). There is, however, a kind of particular 'strength' associated with backtrackers. As we noted earlier, in the case of backtracking examples like (31), backtracking is facilitated by the modalized consequent. The truth conditional import of backtrackers is not just $\alpha \Rightarrow \beta$, but, in more detail, $\alpha \Rightarrow \Box\beta$ (32i). The assertion of this conditional appeals to the lawlike dependency between α and β. Given the relevant laws, α brings about β. This means that there is also in (31) a necessary condition associated with the *would*-conditional: given the laws, it is only if β is true that α will be true (32iii). But, contrary to what we saw in (27), this is not a case of pragmatic strengthening, but an entailment that follows

from the lawlike dependency between α and β. In the absence of the perfection implicature, the utterance of β following the conditional in (27) does not give rise to any inconsistency and thus revision is not justified.

(32) $\begin{bmatrix} \text{i. } \alpha \Rightarrow \Box\beta \\ \text{ii. } \rightsquigarrow \neg\alpha \\ \text{iii. Only if}_{LAW} \; \beta \rightarrow \alpha \end{bmatrix} + \beta$

There is thus no 'reason' to cancel the counterfactuality implicature. Given the modalized consequent and absence of perfection, the utterance of β carries no consequences for the information provided by the *would*-conditional. In terms of the information provided at that point, there is no reason to cancel counterfactuality. It would be bad discourse-manners to do so. We are not allowed.[9]

5.3. In future-shifted conditionals

Future-shifted *would*-conditionals have been subject of much interest in the literature (e.g. Ogihara 2000; Ippolito 2003, 2013; Arregui 2005b, 2007), with perfect aspect examples like (8b) receiving particular attention. Below is an illustrative future-shifted past perfect *would*-conditional:

(33)   If Charlie had taken his Advanced Italian test tomorrow, he would have passed.   (Ippolito 2003)

Suppose that Charlie took his Advanced Italian test yesterday and failed. He could well have benefitted from extra time to study. In such a context, we could utter (33) to claim that if he had taken the exam tomorrow instead of yesterday, he would have passed. In proposing an analysis examples like (33), Ippolito follows Ogihara (2000) in claiming that counterfactuality in these cases is not defeasible. Ippolito illustrates the point with examples like (34):

(34)   #If Charlie had gone to Boston by train tomorrow, Lucy would have found in his pocket the ticket that she in fact found. So, he must be going to Boston by train tomorrow.

---

[9]At this point we would like to remind our readers of our earlier observation that backtracking is sometimes allowed without special syntax. Following Arregui (2005a, b); Schulz (2007), these cases can be characterized as invoking an 'analytic' or necessary relation between antecedent and consequent. For example (inspired by Frank 1996):

(1)   If she were 30 years old today, she would have been born in 1985.

Counterfactuality is hard to cancel in these examples too. A continuation with: *She was born in 1985 so she is probably 30 years old today* is odd. This can be explained along the same lines as the examples above, since backtrackers do not give rise to perfection, so the assertion of the consequent does not generate a contradiction.

There is, as Ippolito points out, the possibility of a confound when faced with examples like (34). In this case we are not only attempting to cancel counterfactuality in a future-shifted conditional, we are also cancelling counterfactuality in a backtracking conditional. Ippolito considers that this confound is not actually problematic, since there are many examples of backtracking conditionals which are acceptable. The difficulty really is with cancellation in future-shifted past perfect examples: *My claim is that what makes ((34)) infelicitous is the attempt to cancel its counterfactuality. Why are past perfect nonfuture subjunctive conditionals and past perfect future counterfactuals so different?* (Ippolito 2013: 26) However, having noted that many backtrackers are acceptable, Ippolito does not actually consider the possibility that what is problematic about examples like (34) is the attempt to cancel counterfactuality in a backtracker, as opposed to a problem in cancelling counterfactuality in a future-shifted past perfect conditional. We have shown that, independently of what happens with future-shifted conditionals, counterfactuality in backtrackers cannot be cancelled. This alone would account for examples like (34). Do we still need to address counterfactuality in future-shifted past perfect conditionals as something special?

We would like to argue that cancelling counterfactuality in future-shifted past perfect conditionals is not in itself a problem, and that the difficulties that have been observed arise as secondary issues associated with other things (like backtracking). It will not be possible to make this point with Anderson-style detective reasoning sequences, since it is necessary to consider examples shifted towards the future in which the consequent isn't true at the speech time (for that would lead to backtracking). We need other ways of showing that future-shifted *would*-conditionals do not entail counterfactuality. A proposal for an argument of this kind is provided below, following the modus-tollens model of Stalnaker's discussion in (5):

(35)   a. It is very unlikely that Susan will go to Washington next Tuesday. If she had gone next Tuesday, she would have met with Obama on Wednesday. But she has an appointment with him for next Saturday. So she will probably will not go next Tuesday.

       b. I really don't think they will have a baby in 2017. If they had had a baby in 2017, they would have had to pay more taxes in 2017. They are very fiscally minded. I think they will wait another year to save up. But then, you never know!

The small discourses in the examples above actually present arguments in favor of the falsity of the future-shifted *would*-conditional (while at the same time leaving open a small door to the possibility that the antecedent may actually be true). The argumentation against the antecedent would not be expected if it was entailed/undefeasible that the antecedent was false (this was the original point made by Stalnaker's argument in (5)).

We may also turn to Lewis's cross-speaker dialogues in the search of conducive environments in which to cancel counterfactuality in future-shifted *would*-conditionals:

(36)   A: It is such a pity Susan will not come for Christmas this year!
       B: Uh?!

> A: Well, if she had come for Christmas this year, her mother would have put together an enormous feast.
> B: Well, you are right about that!! In fact, she has already started the shopping! Didn't you hear? Susan phoned yesterday to say she will come after all!

If, following Lewis's discussion in (6), we consider that examples like this show that that there is cross-speaker agreement on the *would*-conditional, the exchange shows that such agreement does not depend on agreement regarding the falsehood of the antecedent. This would be unexpected if the counterfactuality implicature in future-shifted conditionals was not cancellable.

6. Conclusion

This paper integrates a view of counterfactuality implicatures with discourse-level considerations. We have shown that discourse structure, in particular pertaining to the relation between conditional assertions and QUDs, affects the possibility of cancelling counterfactuality. We have also argued in support of good discourse manners, showing that the cancellation of counterfactuality implicatures cannot be done 'for no reason'. Along the way we have developed a general view of counterfactuality implicatures that sheds light on some well-known examples in the literature without requiring specific constraints.

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Obligatory Triggers under Negation[1]

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Abstract. In this paper, we present two experimental studies which test the different predictions of two theories for the obligatory occurrence of the presupposition triggers "again" and "too" (German "auch" and "wieder") under negation. One theory assumes that "again" and "too" are inserted to avoid a mandatory exhaustivity implicature that contradicts the context. A second theory assumes that the insertion of "again" and "too" follows from a principle *Maximize Presupposition* (Heim 1991). We provide experimental evidence that shows that both triggers are not obligatory under negation. This supports an approach which works with obligatory exhaustivity implicatures and speaks against an analysis using *Maximize Presupposition.*

Keywords: presupposition, implicatures, negation.

1. Introduction

The aim of this paper is to shed new light on the phenomenon of the obligatory use of presupposition triggers. The structure of the paper is as follows. Section 2 provides a theoretical background and outlines two theories on the obligatory insertion of presupposition triggers: *Maximize Presupposition* in section 2.2., and *Obligatory Implicatures* in section 2.3.. In section 3, two experimental studies will be discussed, which tested the obligatoriness of two presupposition triggers under negation. Section 3.1. reports an off-line study on the insertion of the German additive "auch" under negation. Section 3.2. summarizes a study on the insertion of the German iterative "wieder" under negation. Section 4 discusses the results of the two studies. Based on the empirical findings, we suggest that the insertion of "wieder" and "auch" follows from *Obligatory Implicatures.* Furthermore, we argue that presupposition triggers should not be considered a homogeneous class when it comes to their obligatory insertion, given the observations for the insertion of the definite determiner.

2. Theoretical Background

2.1. Obligatory Presupposition Triggers

Presupposition triggers are obligatory when their presupposition is fulfilled in the context, see (1).

(1)   a.   #A sun is shining.
        b.   #All of John's eyes are open.

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      c.   John knows/ #believes that Paris is in France.
      d.   Bill did, #(too).
      e.   Today she went ice skating, #(again).

Two different types of approaches to this phenomenon are discussed in the literature. One approach makes use of the maxim *Maximize Presupposition* (Heim 1991). The focus has first been on obligatory definites, as in examples in (1-a) and (1-b). In recent times, the principle has been extended to obligatory occurrences of other triggers as well, as shown by examples in (1-c.) to (1-e.) (Percus 2006, Chemla 2008, Sauerland 2008).

The second type of approach was first introduced to account for the obligatory insertion of additives, as exemplified by (1-d). It makes use of the fact that sentences without "too" yield contrastive/exhaustivity implicatures (Kaplan 1984, Krifka 1999, Saeboe 2004), which can be blocked by inserting "too". This analysis of obligatory additives has been extended to iteratives and factive verbs recently (Bade 2016). This last theory will be taken as a background for the subsequent discussion. The next two (sub)chapters introduce the different mechanisms these two approaches assume behind the obligatory insertion of presupposition triggers.

2.2. Maximize Presupposition

The principle *Maximize Presupposition* was first introduced to account for the contrast in (2). The definite determiner has to be used when its presupposition is fulfilled, the indefinite determiner will result in infelicity.

(2)   a.   #A father of the victim arrived at the crime scene.
          b.   The father of the victim arrived at the crime scene.

Heim (1991) observes that (2-a.) and (2-b.) are identical on the level of assertion. Both assert the existence of an individual who is the father of the victim and arrived at the crime scene, see (3).

(3) $\exists x[\text{father-of-victim}(x) \,\&\, \text{arrived-cs}(x)]$

The sentences in (2) only differ with respect to their presuppositions. Whereas (2-b) presupposes that there is one unique father of the victim, see (4) (Heim 2012), (2-a) does not have this presupposition.

(4) $\exists x[\forall y[\text{father-of-victim}(y)] \rightarrow x=y]$

The contrast in felicity between the two sentences in (2) cannot be distinguished based on how informative they are. To still account for the contrast, Heim (1991) introduced the following principle:

Maximize Presupposition Make your contribution presuppose as much as possible!

The principle accounts for why (2-b) is preferred over (2-a), it presupposes more. The inference of the indefinite is also explained, via pragmatic reasoning the hearer deduces that the presupposition of the definite does not hold when the indefinite is used. The oddness of (2-a) arises due to the fact that the hearer draws the inference that there is not one unique father of the victim ("antiuniqueness", Heim 1991) which is contradictory to common knowledge.

Recently, the principle has been modified and extended to other presupposition triggers (Schlenker 2012, Sauerland 2008, Percus 2006, Chemla 2008, Singh 2011). More focus was put on the inferences that the sentence without the presuppositional item has. These inferences have been argued to be special since they have characteristics which make them distinct from both implicatures and presuppositions. They have a weak epistemic status but they do also project.

Sauerland (2008) proposes a formulation of the principle *Maximize Presupposition* that there is global pragmatic competition of sentences with regard to their presuppositionality. The account is an extension of his theory on scalar implicatures (Sauerland 2004). Global competition is defined via the set of lexical scales in (5) (Sauerland 2008).

(5)   Scales: {the, every, a, both} , {believe, know} , {SG, PL} , {SPEAKER, HEARER} , {PRES, PAST}

The set of alternative sentences is defined in (6).

(6)   Alt(S) = {S' | the only difference between S and S' are replacements of one member of one of the sets in *Scales* with another element of the same set}

An alternative sentence must satisfy three conditions to block a sentence with the same assertion: its presupposition must be satisfied (7-a.), it must be true (7-b.) and it must have more presuppositions (7-c.). This is spelled out in his formulation of *Maximize Presupposition* in (7) below.

(7)   **Maximize Presupposition** (Sauerland 2008)
        Do not use S in context c if there is an S' such that:
        a. $c \subset$ domain ($[\![$ S' $]\!]$)
        b.   you believe S' to be true

  c. domain($[\![$ S' $]\!]$) $\subset$ domain($[\![$ S $]\!]$)

Not taking the sentence with the strongest presupposition leads to what Sauerland calls an "implicated presupposition", the inference that the presupposition of the competitor is false. Percus (2006), Sauerland (2008) himself and later Singh (2011) and Schlenker (2012) note that complex sentences are a problem for a global version of *Maximize Presupposition*. It cannot account for why triggers are obligatory when their presupposition is locally satisfied, as in (8) and (9) below.

(8) a. If it was raining, John would know it.
    b. #If it was raining, John would believe it.

(9) a. Everyone with exactly two students assigned the same exercise to both of his students.
    b. #Everyone with exactly two students assigned the same exercise to all of his students.

Alternative proposals have been made which assume that *Maximize Presupposition* applies locally (Percus 2006, Chemla 2008, Singh 2011) and works with lexical scales, where items are ordered with regard to their presuppositional strength.

(10) {the, a} , {know, believe} , {too, $\varnothing$}, {again, $\varnothing$} , {both, all}

A formulation of the principle *Maximize Presupposition* which makes use of these ordered sets is given in (11).

(11) **Maximize Presupposition (Percus 2006)**
    a. Alternatives are only defined for lexical items. For any lexical item, the alternatives consist of all "presuppositionally stronger" items of the same syntactic category.
    b. Do not use ϕ if a member of its Alternative Family is felicitous and contextually equivalent to ψ (ϕ is contextually equivalent to ψ iff for all w in the common ground, $\phi(w) = \psi(w)$).

This formulation of the principle accounts for why the presuppositionally stronger item on a scale has to be chosen. The inference arising from using the weaker item ("antipresuppositions", Percus 2006) also arise due to pragmatic reasoning. These new types of inferences have been argued to be distinct from presuppositions and implicatures since they share properties with both, they are epistemically weak but they do project (Sauerland 2008). The latter characteristic is important for the predictions of *Maimize Presupposition* theories regarding the insertion of the trigger under negation.

2.3. Obligatory Implicatures

An alternative proposal was made by Bade (2016), which is based on a grammatical approach to scalar implicatures (Fox 2007, Fox and Hackl 2006, Chierchia et al. 2011). The insertion of the trigger is assumed to be triggered by the fact that sentences are sometimes mandatorily interpreted exhaustively with respect to the Question Under Discussion (QUD) (Roberts 1996). Focus is taken to mark what that QUD is and activates a covert exhaustivity operator with a meaning given in (12) (Fox 2007).

(12)   a. $[\![$ EXH $]\!](A_{<<s,t>,t>})(p_{<s,t>})(w) \Leftrightarrow p(w)$ & $\forall q \in NW(p, A): \neg q(w)$
        b.   NW(p,A) = $\{q \in A:$ p does not entail q$\}$

The operator takes a proposition and a set of alternative propositions and excludes all alternatives which are not entailed by the proposition as false. The exhaustivity operator is assumed to be responsible for the arising of scalar implicatures (Fox 2007, Chierchia et al. 2011). The present account makes use of the operator to derive particularized conversational implicatures, which are argued to be the driving factor for the insertion of the trigger.

The proposal is motivated by observations of Saeboe (2004) and Krifka (1999) who explain the insertion of additive particles by making use of contrastive focus and contrastive topic. Bade (2016) argues that the mechanism is more general and accounts as well for the insertion of "again" and "know". Inferences arising from not using additives, iteratives and "know" occur due to the fact that people sometimes interpret sentences exhaustively with respect to the implicit Question Under Discussion (QUD, (Roberts 1996)) according to this view. A background assumption made is that focus marks the QUD (Beaver and Clark 2008). The alternatives the exhaustivity operator works with are defined via the question set, the set of propositions that are possible answers to the QUD (Hamblin 1973, Karttunen 1977). The EXH operator identifies a proposition p as the most informative answer to the QUD, see (13).

(13) $[\![$ EXH $]\!](Q_{<s,<<s,t>,t>})(p_{<s,t>})(w) \Leftrightarrow p(w)$ &
        $\forall q[q \in Q(w)$ & p does not entail q $\rightarrow \neg q(w)]$

The relevant question is modeled as a covert variable Q that receives its value from the context through the variable assignment function g_c (Heim & Kratzer 1998). The assignment comes with the restriction that the assigned value must be the QUD, see (15-a.). Furthermore there is a restriction that the question set, i.e. the set of possible answers to the QUD, must be a subset of the focus value of the proposition it combines with, see (15-b.) (see Roberts 1996, Rooth 1992).

(14)
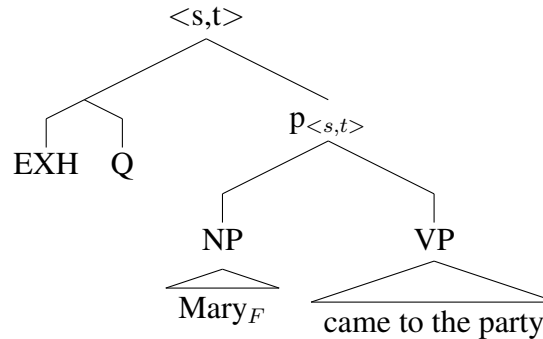
(15) a. $[\![\, Q\,]\!]^g = g_C(Q) = \text{QUD}$
      b. $[\![\, Q\,]\!]^o \subseteq [\![\, p\,]\!]^F$

For example, the proposition in (16-a.) will be interpreted as the exhaustive answer to the implicit QUD "Who was at the party?" since the question set of this QUD is a subset of the focus alternatives generated by the sentence, see (16-b.). The result of this exhaustification is given in (16-b.).

(16) Mary_F was at the party.
       a. $([\![\, \text{Who was at the party}\,]\!])^o \subseteq [\![\, \text{Mary}_F \text{ was at the party}\,]\!]^F$
       b. $[\![\, \text{EXH}\,]\!]([\![\, \text{Who was at the party}\,]\!])([\![\, \text{Mary was at the party}\,]\!])\,(w)$
           $\Leftrightarrow [\text{Mary was at the party}](w)\ \&\ \forall q \in [\lambda p.\exists x.p = \lambda w.\text{person}(x)(w)\ \&\ \text{at-the-party}(x)(w)]$
           $\&\ \text{Mary was at the party does not entail } q \to \neg q(w)]$

The principle can explain the obligatory insertion of "too" in the third sentence in (17) straightforwardly.

(17)   Peter was at the party. He was enjoying himself. Mary was at the party # (too).

If "too" is left out in the third sentence, it is interpreted exhaustively with respect to the QUD "Who was at the party?" due to the mandatory focus on "Mary". This focus marking and exhaustification is obligatory since "Mary" is the only discourse new information. The result of exhaustification that Mary was the only person at the party is contradictory to the context which establishes that Peter came.

A parallel explanation applies to examples containing "again". "This year" carries obligatory focus in the third sentence in (18). It is thus interpreted exhaustively with regard to the question "When was Peter in Norway". The result of this exhaustification is given in (19).

(18)   Peter was in Norway last year. It rained a lot. Peter was in Norway #(again) this year$_F$.

(19) $\llbracket$EXH$\rrbracket$($\llbracket$When was Peter in Norway$\rrbracket$)($\llbracket$Peter was in Norway this year$\rrbracket$) (w)
         $\Leftrightarrow$ [Peter was in Norway this year](w) & $\forall q \in [\lambda p.\exists t.p = \lambda w$ [time(t)(w) & Peter was in Norway at t in w] & Peter was in Norway this year does not entail q $\rightarrow \neg q(w)$]

As before, exhaustification results in a contradiction with the context which yields the oddness of the discourse in (18).
The insertion of a presupposition trigger will prevent this contradiction from arising since it blocks exhaustification. To see this one needs to look at the truth conditions of the third sentence in (18) with "again", see (20) (see Beck 2007).

(20) $\llbracket$ Peter was in Norway $again_{t_1}$ this year $\rrbracket^w$ = is defined only if Peter was in Norway at g(1) and g(1) < this year. If defined, it is true iff Peter was in Norway this year.

In the sentence in (20), g(1) will be mapped onto "last year" since it is the closest antecedent. The definedness conditions of the sentence are only fulfilled when exhaustification is blocked, since the alternative which would be excluded is now presupposed to be true.
A parallel effect is yielded by the insertion of "too" in (21-b.) below.

(21)   a.   Peter came to the party.
         b.   Mary came to the party, too.

"Too" also uses the alternatives given in the context, see the interpretation of (21-b.) is given in (22).

(22) $\llbracket$ Mary came to the party, too$_C$ $\rrbracket$ = is defined only if $\exists p \in C$ & p(w) & p$\neq \lambda$w. Mary came to the party in w. If defined, it is true iff Mary came to the party in w.

Since the only salient alternative in C in this context is "Peter came to the party", it is presupposed to be true. Hence, the exhaustivity operator does not have to be activated to make use of this alternative and a contradiction does not arise.

3. Experiments

The idea behind the two experiments which will be reported is to test the different predictions of *Maximize Presupposition* and *Obligatory Implicatures* regarding the obligatory insertion of the

German triggers "wieder" ("again") and "auch" ("also").

3.1. "Auch" under negation

3.1.1. Predictions

According to *Maximize Presupposition* the trigger "too" is obligatory in (23-c.) since its presupposition if fulfilled by (23-a.). The negated sentence without the trigger (23-b.) violates *Maximize Presupposition* and thus (23-c.) should be preferred. The meaning of (23-c.) is given in (23-d.). The inference arising from using (23-b.) is given in (23-e.). It says that the presupposition of (23-d.) is false.

(23) a. Mary came to the party.
      b. Bill did not come to the party.
      c. Bill did not come to the party, too.
      d. $[\![\,[\,\text{not}\,[\text{too C}]\,[\text{Bill}_F\ \text{come to the party}\,]\,]\,]\!]) = \lambda w: \exists p\,[p \in C\ \&\ p(w) = 1\ \&\ p \neq \lambda w.\text{Bill}$ came to the party in w]. Bill did not come to the party in w
      e. $\Rightarrow \neg \exists p\,[p \in C\ \&\ p(w)\ \&\ p \neq \lambda w.\text{Bill came to the party in w}]$

According to *Obligatory Implicatures* "too" should be inserted if the sentence in (23-b.) yields an exhaustivity implicature which is contradictory to (23-a.). There are two possible attachment sites for the exhaustivity operator in (23-b.), above and below negation. If the operators is above negation and focus remains on "Bill", the QUD must change to "Who did not come?" to satisfy question-answer-congruence, see (24).

(24)
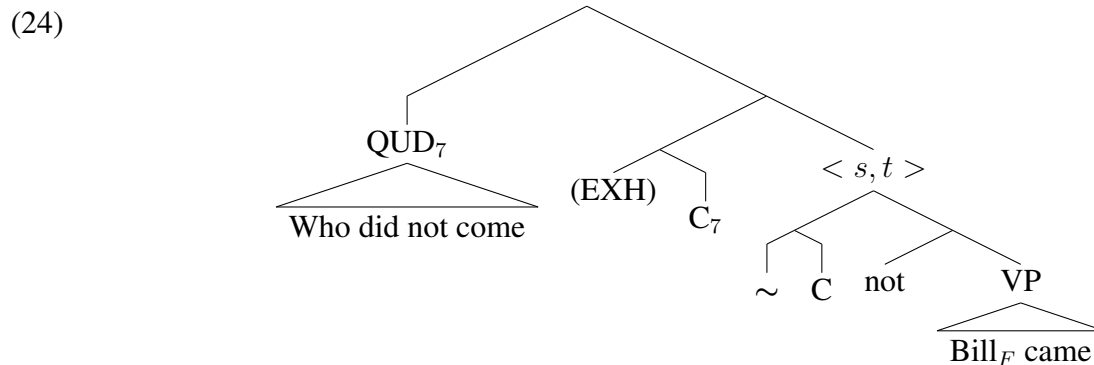
This configuration does not yield an implicature which is contradictory to the fact that Mary came. The result of exhaustification is given in (25), it says that Bill is the only person who did not come.

(25)   ⟦ EXH ⟧(⟦ Who did not come to the party ⟧)(⟦ Bill did not come to the party ⟧) (w)
         ⟺ [Bill did not come to the party](w) & ∀q [q ∈ [λp.∃x.p = λw.person(x)(w) & ¬ at-the-
         party(x)(w)] & Bill did not come to the party does not entail q] → ¬q(w)]
         'Only Bill did not come to the party.'

The second option is that the exhaustivity operator attaches below negation, see (26).

(26)
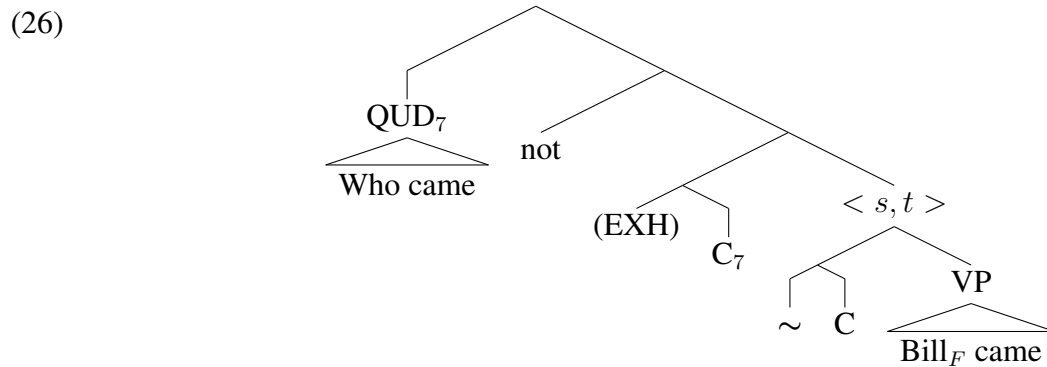
If focus remains on "Bill", the QUD has to be "Who came to the party?". The corresponding
exhaustivity implicature is the one in (27).

(27)   ⟦ not ⟧(⟦ EXH ⟧ (⟦ Who came to the party ⟧)(w)(⟦ Bill came to the party ⟧)) ⟺ ¬ [[Bill
         came to the party](w) & ∀q ∈ [λp.∃x.p = λw.person(x)(w) & at-the-party(x)(w)] & Bill
         came to the party does not entail q → ¬q(w)]
         # "It is not the case that Bill was the only person at the party."

For scalar implicatures it has been argued that this reading exists, but that it is limited in its avail-
ability and involves meta-linguistic negation (Horn 1989, Chierchia et al. 2011), see (28).

(28)   John didn't see Mary or Sue, he saw both. (Chierchia et al. 2011)

For particularized conversational implicatures like (27) this reading seems to be impossible alto-
gether, compare (29).

(29)   ??John didn't come to the party, Mary and John came.

Interestingly, inserting the exhaustivity operator below negation should thus be ruled out for par-

ticularized conversational implicatures since it yields an unattested reading. The operator can be inserted above negation but exhaustification does not yield a contradiction with the context. Since the contradiction is the reason for the insertion of the trigger under *Obligatory Implicatures*, the trigger is not expected to be obligatory in (23-b)[2].

In sum, *Maximize Presuppositions* predicts a main effect of leaving out the trigger in both affirmative and negated sentences. In both cases, the version without the trigger should be significantly worse than the version with the trigger. In both cases *Maximize Presupposition* is violated.

For *Obligatory Implicatures*, the predictions are that there is an interaction between having to insert the trigger and polarity of the sentence the trigger could occur in. In negated sentences, leaving out the trigger should be as acceptable as inserting it. In affirmative sentence, inserting the trigger should be significantly more acceptable than leaving it out.

3.1.2. Material and design

Creating the material for an acceptability rating study testing the insertion of "too" under negation is complicated by the fact that "too" and negation are ungrammatical when appearing in one sentence, both in German and in English due to an intervention effect (see Beck 2006, 2016), see (30-a.) and (30-b.) (Oesterle 2015).

(30)   Peter came to the party. / Peter ist zur Party gekommen.

     a.   #John did not come to the party, too.

     b.   #Johannes ist nicht auch zur Party gekommen.

This confounding factor for testing the acceptability of sentences with "too" under negation can be avoided by using high negation like in (31-b.), which is why it was used for the material of the study reported.

(31)   a.   Peter came to the party.

     b.   It is not the case that John came to the party, (too).

     c.   It is the case that John came to the party (too).

For the design of the study, the two factors TOO and NEGATION were crossed. The first factor TOO appeared in the conditions "with too" and "without too". The second factor NEGATION appeared in the conditions "with negation" and "without negation". The target thus appeared in four conditions.

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[2]There is a third possibility which is not discussed here where negation itself is focused and the question must be a polar one. Exhaustification is not contradictory to the context in this case, either, and thus this datum does not change the predictions of *Obligatory Implicatures*.

A sample item in all four conditions is given below (Oesterle 2015: p.17-18).

(32)   Context: Lukas und Melanie sind beide passionierte Kinogänger. Sie haben vereinbart,
         am Freitag gemeinsam ins Kino zu gehen, wenn sie beide Zeit haben. Lukas hat am
         Freitag Zeit.
         'Lukas and Melanie like to go to the cinema together. They agreed to go to the cinema on
         Friday, if both have time. Lukas has time to go on Friday.'

         a.   Es ist nun so, dass auch Melanie am Freitag Zeit hat. Deswegen reservieren die
               beiden Karten für die Spätvorstellung.
               'It is the case that Melanie has time to go on Friday, too. This is why they order
               tickets for the late show.' (-NEG, +TOO)
         b.   Es ist nun so, dass Melanie am Freitag Zeit hat. Deswegen reservieren die beiden
               Karten für die Spätvorstellung.
               'It is the case that Melanie has time to go on Friday This is why they order tickets for
               the late show.' (-NEG, -TOO)
         c.   Es ist nun nicht so, dass auch Melanie am Freitag Zeit hat. Deswegen überlegen sie
               sich einen anderen Termin.
               'It is not the case that Melanie has time to go on Friday, too. This is why they are
               trying to find another time.' (+NEG, -TOO)
         d.   Es ist nun nicht so, dass auch Melanie am Freitag Zeit hat. Deswegen überlegen sie
               sich einen anderen Termin.
               It is not the case that Melanie has time to go on Friday, too. This is why they are
               trying to find another time.' (+NEG, +TOO)

Participants saw both the context and target on a computer screen and were asked to read the
context carefully. They were then presented with the target sentence in one of the conditions in
a grey box. They were asked to rate the acceptability of the target within the context on a scale
from 1 to 7, where 7 meant "completely acceptable" (Oesterle 2015). They were advised that
"acceptable" meant that the sentence made sense in the context and could be uttered by a native
speaker.

3.1.3. Results

Oesterle (2015) found a significant interaction between the factors TOO and NEGATION. Without
negation, the sentences with "too" were judged significantly better (p<.01, M = 5 with "too", M=
3,9 without "too"). With negation, the sentences without "too" were judged better (M = 3,6 without
"too", M = 3,5 with "too"). There were significant main effects for both TOO and NEGATION, but
in opposite directions. The presence of the trigger generally increased the acceptability of the
sentences (p<.01), the presence of negation generally decreased the acceptability of sentences

(p<.01). There was a significant simple effect for negation in the conditions -TOO and +TOO. The +NEGATION condition was significantly worse than -NEGATION both with the trigger (p<.01) and without the trigger (p<.05). There was no simple effect of TOO for +NEGATION. For +NEGATION there was a significant simple effect, the sentences with the trigger were judged significantly better than without the trigger (p<.01).

The results are summarized in the table in 1 below (see Oesterle 2015: p.21-22).
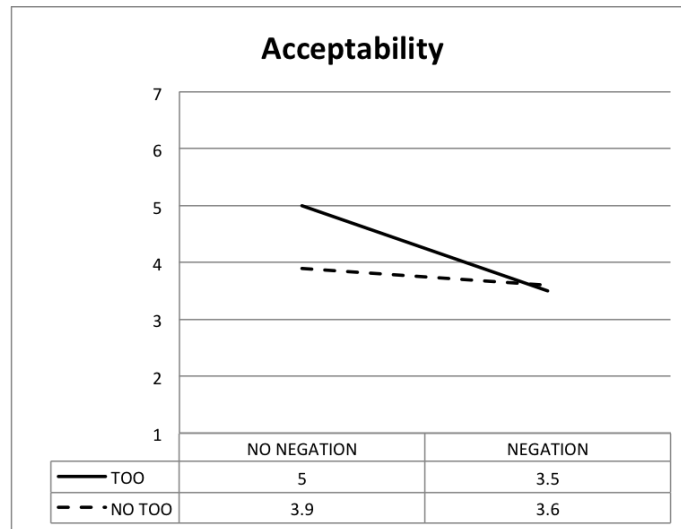
Figure 1: Mean average acceptability for sentences with or without "too" in sentences with or without negation

3.2. "Again" under negation

3.2.1. Idea and predictions

The two theories introduced differ in their empirical predictions for the obligatoriness of "again" in a sentence with negation, see (33-b.). *Maximize Presupposition* predicts the sentence in (33-b.) to be as degraded as (32-b.). *Obligatory Implicatures* predicts (33-b.) to be acceptable as opposed to (32-b.).

(33)   a.   John went to Norway last year.
        b.   He did not go to Norway this year.

The explanation for this difference in predictions is parallel for the one for "too" discussed above. For *Maximize Presupposition* (33-b.) should be degraded since it has a presuppositionally stronger

competitor with "again" which has not been used, see (34). The speaker via deductive reasoning assumes the presupposition of (33-b.) (given in (34-a.)) to be false, see (34-b.). As for the affirmative case, this should yield a contradiction with (33-a.).

(34)   He did not go to Norway this year, again.

    a. $[\![$ not [[John did go to Norway again$_{t_1}$] this year] $]\!]$ = λw: John went to Norway in w last year. Joe did not go to Norway this year in w.

    b. $\neg$ John went to Norway in w last year.

Obligatory Implicatures does not predict "again" to be obligatory in (33-b) since the implicature resulting from exhaustifying the QUD does not yield a contradiction. As was discussed for "too" in the last section, there are two syntactic positions for the exhaustivity operator, below and above negation. When the operator has scope over negation, exhaustification does not result in a contradiction, see (35) and its interpretation in (36).

(35)
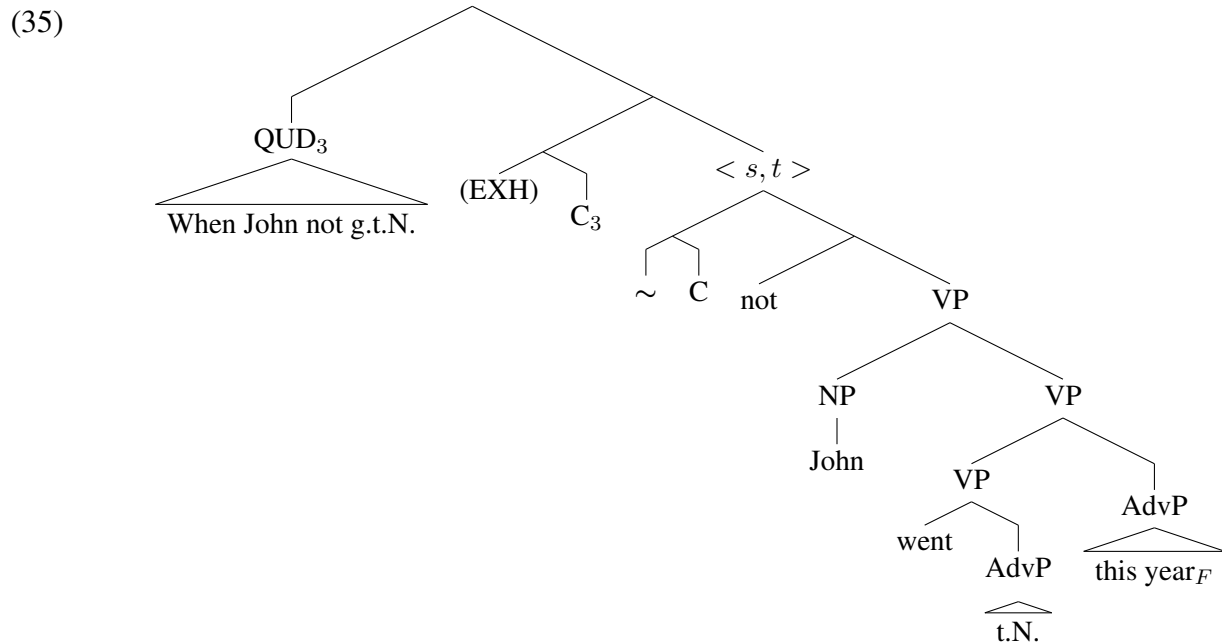
(36) $[\![$ EXH $]\!]$($[\![$When was John not in Norway$]\!]^w$)($[\![$John was not in Norway this year $]\!]$)(w) $\Leftrightarrow$ [John was not in Norway this year](w) = 1
& $\forall$q [q $\in$ [λp.$\exists$t.p = λw [time(t)(w) & John was not in Norway at t in w]] & John was not in Norway this year does not entail q] $\rightarrow$ $\neg$q
'This year was the only time John did not go to Norway.'

The LF where EXH has scope below negation should be ruled out for independent reasons since it yields an unattested reading for the sentence with negation, see (37) and the interpretation in (38).

(37)
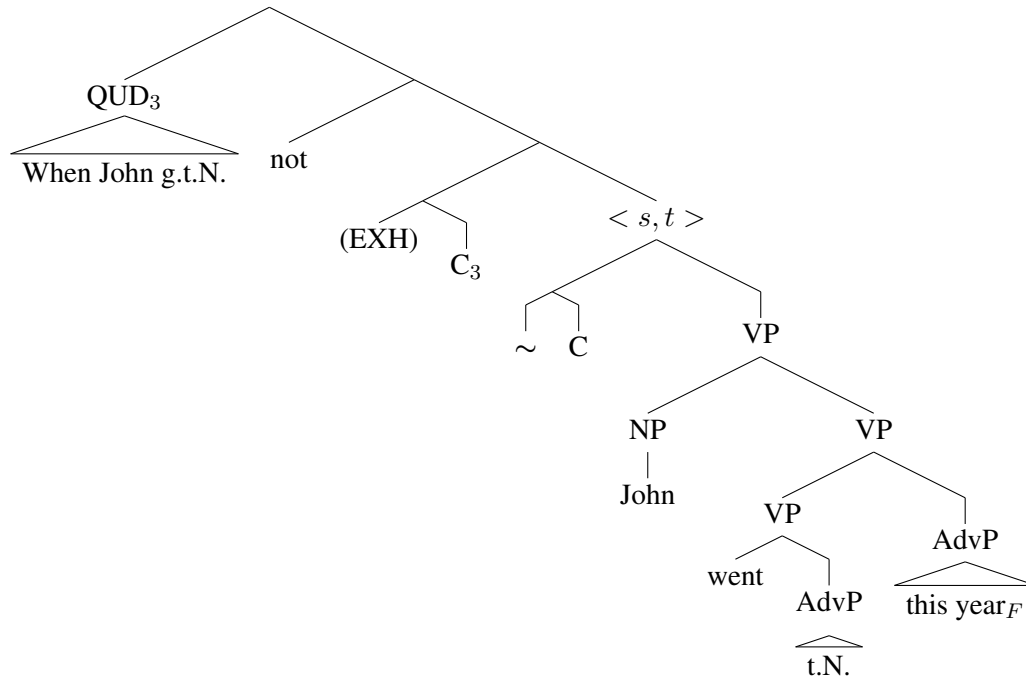
(38) $[\![$ NOT $]\!]$ ($[\![$ EXH $]\!]$($[\![$When was John in Norway$]\!]^w$)($[\![$John was in Norway this year $]\!]$)(w))
        $\Leftrightarrow \neg$ [[John was in Norway this year](w) & $\forall$q [q $\in$ [λp.$\exists$t.p = λw [time(t)(w) & John
        was in Norway at t in w]] & John was in Norway this year does not entail q] $\rightarrow \neg$q(w)]
        # 'It is not the case that only this year John went to Norway.'

Obligatory Implicatures does not predict "again" to be obligatory under negation since its insertion either does not yield a contradiction or is ruled out for independent reasons. Even if the reading was not ruled out, it would not be contradictory to a context where the presupposition of "again" is fulfilled either.

3.2.2. Design and material

For the material, contexts were created that introduced the general setting and two protagonists. One of the protagonists uttered a sentence, see (40). This first utterance always satisfied the presupposition of again. The second target appeared in four different conditions, see (40-a.-d.).

(39) Sonja und Nadine sind Kollegen. Sie unterhalten sich über Freizeitaktivitäten, die sie
      letzte Woche gemeinsam unternommen haben. Sonja sagt:
      'Sonja and Nadine are colleagues. They are talking about activities they did together last
      week. Sonja says:'

(40) Wir waren am Dienstag schwimmen.
      'We went swimming on Tuesday.'
      a. Am Freitag waren wir wieder schwimmen.
          'We went swimming on Friday, again.' (-negation, +again)
      b. Am Freitag waren wir schwimmen.
          'We went swimming on Friday.' (-negation, -again)
      c. Am Freitag war wir nicht wieder schwimmen.
          'We did not go swimming on Friday, again.' (+negation, +again)
      d. Am Freitag waren wir nicht schwimmen.
          'We did not go swimming on Friday.' (+negation, -again)

A 2x2 design was used for the study which crossed the two factors AGAIN and NEGATION. The
second target sentence thus appeared in one of the following four conditions: with "again" and
without negation (40-a.), without "again" and without negation (40-b.), with "again" and with
negation (40-c.), or with negation and without "again" (40-d.). Six items were created for each
condition, making for 24 experimental items in total. In addition the study contained 48 filler
items (Bade 2016).

3.2.3. Procedure

The experiment was created using the free software OnExp (Onea Onea). 28 native speakers of
German participated in the experiment. They did the experiment on-line (using their own web
browser on their home computer), after receiving a link to the experiment. People were asked
to read the context carefully and then read the two target sentences, always uttered by a person
appearing in the context. The target sentences were presented separately in a gray box on the
computer screen. Participants were then instructed to judge the second target sentence in the given
context on an acceptability rating scale ranging from 1 to 5 (5 meant completely acceptable).

3.2.4. Results

Analyses were carried out using the R programming language (R Development Core Team) as lin-
ear mixed effect models (Baayen et al. 2008), using the program *lmer* (Bates 2005). The fixed fac-
tors were AGAIN (present/absent) and NEGATION (present/absent). Random factors were subjects

and items. Additionally, models with random slopes for both subjects and items were calculated. When an ANOVA revealed a significant difference between the models, the more complex one was chosen.

A significant interaction was found between the factors AGAIN and NEGATION ($p<.01$). Furthermore, highly significant simple and main effects were found for both factors (all $p<.01$). Whereas without negation the acceptability of the sentence significantly increased with the insertion of again (M=1,76 without "again" and M=3,64 with "again"), it decreased the acceptability of sentences with negation (M=3,18 without "again" and M=2,8 with "again"). The results are summarized in 2 below (Bade 2016).
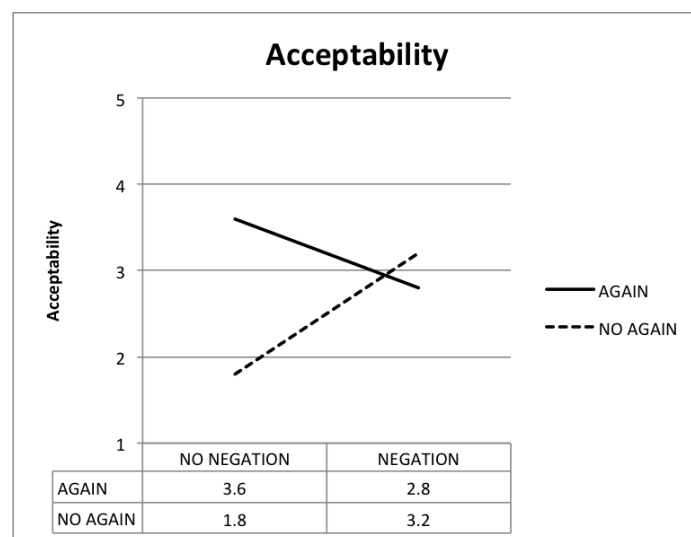
Figure 2: Mean acceptability of sentences with "again" and with negation, with "again" and without negation, without "again" and without negation, without "again" and with negation

4. Discussion

The findings overall support the view of *Obligatory Implicatures* on the obligatory insertion of the triggers "again" and "too". According to *Maximize Presupposition*, sentences should be worse without the triggers, regardless of negation. Even though there was the predicted main effect of the insertion of the trigger, there was also a significant interaction which is unexplained by *Maximize Presupposition*. With negation, the acceptability of sentences did not improve with the insertion of "too" whereas in affirmative sentence the acceptability significantly increased with inserting the trigger. For "again", the acceptability of sentences with "again" even decreased in the presence of negation. Following *Obligatory Implicatures*, this could be due to the fact that both "again" and negation give contradicting signals as to what is at issue. Whereas "again" seems to suggest a QUD of the form "When did something happen", negation suggests that a polar question needs to be answered.

The fact that "again" and "too" are not obligatory under negation speaks in favor of *Obligatory*

Implicatures. However, what about presuppositional determiners? Without further empirical evidence, it is clear that definites are obligatory, irrespective of whether the sentence is negated, see (41).

(41)   a.   #A father of the victim did not arrive at the crime scene.
         b.   The father of the victim did not arrive at the crime scene.

Inserting the trigger in (41-b.) does not seem to be a result of an obligatory implicature of (41-b.) (see Bade (2016) for extensive discussion), it is thus not in the range of phenomena to be explained based on *Obligatory Implicatures*. A possible conclusion is that *Maximize Presupposition* is a principle that applies to morphological features (including definiteness) which require one or the other setting. It thereby necessarily applies locally which makes a distinction between local and global versions of *Maximize Presupposition* superfluous. Triggers thus fall into two classes with regard to their obligatory insertion. The obligatory insertion of the triggers "too" and "again" is a global pragmatic mechanism based on *Obligatory Implicatures*. The obligatory insertion of definite determiners and other features is a local mechanism based on the principle *Maximize Presupposition*. Both principles should remain in the inventory of mechanisms grammar has to offer.

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Severing maximality from *fewer than*: evidence from genericity [1]

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Abstract. This paper presents new evidence suggesting that the downward entailingness of a quantifier like *fewer than four people* is due not simply to the lexical meaning of the quantifier, but also to a separate, and in principle optional, maximization operation that occurs in the scope of the quantifier, a decomposition already posited for independent reasons by Spector (2014).

Keywords: quantification, plurality, modified numerals, distributivity, collectivity, genericity

1. Introduction

This paper concerns the role that maximality plays in the semantics of (sentences containing) the numeral modifier *fewer than*. On the basis of new data involving generic readings of quantificational noun phrases of the form *fewer than n NP*, I argue that the maximality component normally associated with *fewer than* should be viewed as an optional component that is separate from the meaning of *fewer than*. I start by presenting what I call 'maximal' and 'non-maximal' readings of sentences in which *fewer than n NP* contributes existential force, and the puzzle that the existence of such readings gives rise to. In section 2, I present two recent theories of the puzzle and show that, for the core existential data, the two theories are on a par. In section 3, I present new data from the generic domain, which, in section 4, I show can only be captured by one of the two theories. Section 5 discusses some extensions and predictions. Section 6 concludes.

1.1. Maximal readings

One main intuitive difference between *more than* and *fewer than* is that the latter, but not the former, normally conveys an upper bound. For example, (1a), but not (1b), conveys an upper bound of three on the number of students who (may have) attended. Put differently, (1a), but not (1b), intuitively entails (1c).

(1)   a.   Fewer than four students attended.
           b.   More than three students attended.
           c.   It is not the case that more than three students attended.

In addition, (1a), but not (1b), does not entail any lower bound: it is compatible with no students having attended. To be sure, (1a) may implicate that some student(s) attended, but, in line with Generalized Quantifier Theory (Barwise and Cooper, 1981), I do not take this to be part of the

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literal meaning of (1a). For example, *Every colloquium was attended by fewer than four students* is judged true even if some colloquia were attended by no students at all. That the lower-bound inference disappears in such environments is unsurprising if it is a kind of implicature (cf. *Every colloquium was attended by some of the students*, which is true even if some colloquia were attended all of the students).

The following is thus an appropriate representation of the meaning of (1a) (cf. Hackl, 2000; Nouwen, 2010; Kennedy, 2015).[2, 3]

(2)   a. $\max(\lambda n . \exists x[\#x = n \wedge \textbf{students}(x) \wedge \textbf{attended}(x)]) < 4$
       b.   'The maximum number of students who attended, if any, is less than 4.'

Let us call such a reading – one that conveys an upper bound – a MAXIMAL reading, and note that no other reading is available for (1a).

1.2. Non-maximal readings

Surprisingly, when *fewer than four* combines with (certain) non-distributive predicates, we do not get the same kind of maximal reading (Buccola, 2015b; Spector, 2014; Solt, 2007; Ben-Avi and Winter, 2003; Winter, 2001; Van der Does, 1992; Scha, 1981). For example, in (3a), a collective interpretation of *lifted the piano* is forced by *together*, and (3a) does *not* entail (3b): in a context where, say, three semantics students lifted the piano together, and seven phonology students lifted the piano together, (3a) is true, while (3b) is false.

(3)   a.   Fewer than four students lifted the piano together.
       b.   It is not the case that more than three students lifted the piano together.

This case is thus markedly different from that of (1a): if three semantics students attended, and seven phonology students attended, then (1a) is false despite the existence of a salient group of fewer than four attending students.

Moreover, (3a), unlike (1a), appears to entail a lower bound, viz. that some student(s) lifted the piano. This entailment explains why a sentence like *Fewer than four babies lifted the piano together* feels false (or, if true, then extremely surprising) in normal contexts. By contrast, *Fewer than four babies were smoking*, though admittedly odd (due to the implicature), nevertheless does not feel false in most normal contexts; for instance, it can be followed up with, *Yes, I agree, because no babies were smoking (thankfully)*.

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[2]Here, *x* ranges over sums of individuals (Link, 1983), and # is a function that maps a sum *x* to the cardinality of *x*, i.e. to that number *n* such that *x* has *n* atomic parts. There are, of course, other ways to represent this meaning.

[3]I use the terms *sum*, *plurality*, and *group* interchangeably, with no theoretical distinction between them.

In sum, (3a) simply means that a group of fewer than four students lifted the piano, which we may represent as follows.

(4)   a. $\exists x [\#x < 4 \wedge \mathbf{students}(x) \wedge \mathbf{lifted}(x)]$
        b.   'A group of fewer than four students lifted the piano.'

In a completely parallel way, in (5a), a cumulative interpretation of *drank more than twenty beers* is forced by the expression *between them*, and (5a) does *not* entail (5b): in a context where, say, three semantics students drank 21 beers between them, and all the students together drank 30 beers between them, (5a) is true, while (5b) is false.

(5)   a.   Fewer than four students drank more than twenty beers between them.
        b.   It is not the case that more than three students drank more than twenty beers bw. them.

And once again, (5a) entails a lower bound, viz. that at least some student(s) drank more than twenty beers between them. In sum, (5a) simply means that a group of fewer than four students drank more than twenty beers, which we again may represent as follows.[4]

(6)   a. $\exists x [\#x < 4 \wedge \mathbf{students}(x) \wedge \mathbf{drank\_more\_than\_20\_beers}(x)]$
        b.   'A group of fewer than four students drank more than twenty beers.'

Let us call such readings – ones that make a simple existential statement, without conveying any overall upper bound – NON-MAXIMAL (or EXISTENTIAL) readings.

1.3. Inadequate representations

Clearly, the non-maximal readings of (3a) and (5a) cannot be represented on analogy with the maximal reading of (1a), by using a maximality operator, as below, for these representations incorrectly predict that (3a) and (5a) should entail (3b) and (5b), respectively, and they incorrectly predict that (3a) and (5a) should not entail any lower bound.[5]

(7)   a. $\max(\lambda n \,.\, \exists x [\#x = n \wedge \mathbf{students}(x) \wedge \mathbf{lifted}(x)]) < 4$
        b.   'No group of more than three students lifted the piano.'

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[4]I will say nothing more in this paper about cumulatively interpreted predicates. The point here is just to give another example of a non-maximal reading of a sentence involving *fewer than*. For more on cumulative interpretations of transitive predicates in this regard, see Buccola and Spector (2016).

[5]Whether or not (3a) and (5a) *also* have these maximal readings (i.e. are ambiguous between a maximal reading and a non-maximal one) is an open empirical question; see Buccola and Spector (2016) for discussion. The point here is that they clearly have non-maximal readings, which cannot be represented by a formula involving a (wide-scope) maximality operator.

(8)   a. $\max(\lambda n \, . \, \exists x[\#x = n \wedge \mathbf{students}(x) \wedge \mathbf{drank\_more\_than\_20\_beers}(x)]) < 4$
       b.   'No group of more than three students drank more than twenty beers.'

Conversely, the maximal reading of (1a) cannot be represented on analogy with the non-maximal readings of (3a) and (5a), viz. as a simple existential statement about groups, since this leads to what is known as Van Benthem's problem (Van Benthem, 1986): saying that a group of fewer than four students attended amounts to saying that at least one student attended.[6, 7]

(9)   a.   Fewer than four students attended.
       b. $\exists x[\#x < 4 \wedge \mathbf{students}(x) \wedge \mathbf{attended}(x)]$
             $\equiv \exists x[\mathbf{students}(x) \wedge \mathbf{attended}(x)]$
       c.   'At least one student attended.'

1.4. Puzzle and roadmap

As the above discussion illustrates, the presence of maximality in sentences involving *fewer than* is, in some sense, variable, depending on the types of predicates that *fewer than n* combines with. The puzzle, then, is: What explains the variable presence of maximality? In the next section, I review two recent accounts of the puzzle. The first account, which I call 'Lexical Maximality' (LMax), proposes that *fewer than* lexically encodes reference to maximality, and that the variable presence of maximality is due to the variable scope of *fewer than* relative to covert existential quantification (Buccola, 2015b). The second account, which I call 'Separate Maximality' (SMax), proposes that the variable presence of maximality is due to the optional application of a maximization operation that is separate from the meaning of *fewer than* (Spector, 2014). I will show that, for the core data above, LMax and SMax are completely on a par: they generate exactly the same set of readings, up to truth-conditional equivalence. In section 3, I introduce data from the generic domain (generically interpreted sentences that contain *fewer than*), which I argue support SMax over LMax. Section 5 explores some extensions and predictions. Section 6 concludes.

2. Two theories

Both Buccola (2015b) and Spector (2014) propose that both maximal and non-maximal (existential) readings are grammatically generated across the board, and that certain 'weak' readings, in which

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[6]Proof: ($\Rightarrow$) Let z be a group of fewer than four students who attended. Then, on the standard assumption that there is no empty group, it follows that one or more students attended. ($\Leftarrow$) Let z be a group of one or more students who attended. Then every atomic part of z is a student who attended, which means there is a group of fewer than four students who attended (namely, any atomic part of z).

[7]This equivalence relies on the assumption that a plural noun phrase like *students* may contain atomic individuals in its extension, but this assumption in unnecessary for the argument at hand: if the extension of *students* contains only plural individuals of cardinality 2 or more, then $\exists x[\#x < 4 \wedge \mathbf{students}(x) \wedge \mathbf{attended}(x)]$ is equivalent to $\exists x[\#x = 2 \wedge \mathbf{students}(x) \wedge \mathbf{attended}(x)]$, i.e. 'At least two students attended', which is just as inadequate.

the modified numeral makes no semantic contribution, are systematically ruled out by pragmatic blocking constraint, a version of which is provided in (10).

(10)   **Pragmatic blocking constraint**
         If an LF ϕ contains a numeral n, then for any numeral m distinct from n, substituting m for n in ϕ must yield different truth conditions.

The two theories differ mainly in their method of overgeneration, as explained shortly. For both theories, let us assume that a numeral n denotes a degree (number) but can also optionally be interpreted as an intersective adjective (see Landman, 2004), which I write as n_{isCard}.

(11)   a. $[\![\text{one}]\!] = 1$, $[\![\text{two}]\!] = 2$, $[\![\text{three}]\!] = 3, \ldots$
         b. $[\![n_{\text{isCard}}]\!] = \lambda x \,.\, \#x = [\![n]\!]$
         c. $[\![n_{\text{isCard}} \text{ students}]\!] = \lambda x \,.\, \#x = [\![n]\!] \wedge \textbf{students}(x)$

2.1. Lexical maximality and scope ambiguity

On the Lexical Maximality (LMax) approach of Buccola (2015b), a modified numeral like *fewer than four* denotes a generalized quantifier over degrees, which lexically encodes a maximality operator (cf. Heim, 2000; Hackl, 2000), and numerical indefinites like *fewer than four students* are headed by a silent existential determiner, $\varnothing_{\exists}$ (cf. Link, 1984, 1987; Krifka, 1999).

(12) $[\![\text{fewer than four}]\!] = \lambda P_{dt} \,.\, \max(P) < 4$

(13) $[\![\varnothing_{\exists}]\!] = \lambda P_{et} \,.\, \lambda Q_{et} \,.\, \exists x[P(x) \wedge Q(x)]$

In an expression like (14), *fewer than four* is uninterpretable and must move. The basic insight of the LMax approach is that *fewer than four* may interact scopally with $\varnothing_{\exists}$ to derive the two kinds of readings (maximal and non-maximal) that we are interested in.

(14) $[_{\text{DP}} \varnothing_{\exists} [_{\text{NP}} [_{\text{AP}} \text{ fewer than four}] \ldots]] [_{\text{VP}} \ldots]$

When *fewer than four* scopes above $\varnothing_{\exists}$, i.e. adjoins to S, we get a maximal reading.

(15)   a. $[\text{fewer than four}] [\lambda n [[\varnothing_{\exists} [n_{\text{isCard}} \text{ NP}]] \text{ VP}]]$
         b. $\max(\lambda n \,.\, \exists x[\#x = n \wedge [\![\text{NP}]\!](x) \wedge [\![\text{VP}]\!](x)]) < 4$

This is precisely the reading we want for a sentence like (1a) with a distributive predicate.[8]

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[8]Again, it is unclear whether maximal readings are also available for sentences with collectively interpreted predicates (see footnote 5). If they are not, then LMax and SMax both face a problem, since the constraint in (10) does not exclude

(16)   a.   [fewer than four] [λn [[$\varnothing_\exists$ [$n_{\texttt{isCard}}$ students]] attended]]
        b. $\max(\lambda n . \exists x[\#x = n \wedge \textbf{students}(x) \wedge \textbf{attended}(x)]) < 4$
        c.   'The total number of students who attended is less than 4.'   ✓

When *fewer than four* scopes below $\varnothing_\exists$, i.e. quantifies into AP (shown below) or (equivalently, but not shown) into NP (Heim and Kratzer, 1998), we get a non-maximal, i.e. existential, reading.

(17)   a.   [$\varnothing_\exists$ [[$_{\text{AP}}$ λx [[fewer than four] [λn [x $n_{\texttt{isCard}}$]]]] NP]] VP
        b. $\exists x[\max(\lambda n . \#x = n) < 4 \wedge [\![\text{NP}]\!](x) \wedge [\![\text{VP}]\!](x)]$
              $\equiv \exists x[\#x < 4 \wedge [\![\text{NP}]\!](x) \wedge [\![\text{VP}]\!](x)]$

For a sentence like (1a) with a distributive predicate, this reading is blocked by the constraint in (10) because replacing *four* by any other numeral yields the same weak reading, following the logic of Van Benthem's problem.

(18)   a.   [$\varnothing_\exists$ [[λx [[fewer than four] [λn [x $n_{\texttt{isCard}}$]]]] students]] attended
        b. $\exists x[\#x < 4 \wedge \textbf{students}(x) \wedge \textbf{attended}(x)]$
              $\equiv \exists x[\#x < 3 \wedge \textbf{students}(x) \wedge \textbf{attended}(x)]$
              $\equiv \exists x[\#x < 5 \wedge \textbf{students}(x) \wedge \textbf{attended}(x)]$
              $\equiv \exists x[\textbf{students}(x) \wedge \textbf{attended}(x)]$
        c.   'A group of fewer than four students attended.'
              $\rightsquigarrow$ 'At least one student attended.'   BLOCKED

Crucially, for a sentence like (3a) with a non-distributive predicate, the non-maximal reading is correctly *not* blocked: replacing *four* by *three* yields a stronger meaning, and replacing *four* by *five* yields a weaker meaning.

(19)   a.   [$\varnothing_\exists$ [[λx [[fewer than four] [λn [x $n_{\texttt{isCard}}$]]]] students]] [lifted the piano together]
        b. $\exists x[\#x < 4 \wedge \textbf{students}(x) \wedge \textbf{lifted}(x)]$
              $\not\equiv \exists x[\#x < 3 \wedge \textbf{students}(x) \wedge \textbf{lifted}(x)]$
              $\not\equiv \exists x[\#x < 5 \wedge \textbf{students}(x) \wedge \textbf{lifted}(x)]$
              $\not\equiv \exists x[\textbf{students}(x) \wedge \textbf{lifted}(x)]$
        c.   'A group of fewer than four students lifted the piano.'   ✓

On the LMax approach, the 'absence' of maximality here is due to the fact in (20), which in turn is due to the fact that every plural individual has exactly one cardinality.

(20)   **Fact.** For all individuals x, $\max(\lambda n . \#x = n) = \#x$.

them.

2.2. Separate and optional maximality

The Separate Maximality (SMax) approach of Spector (2014) posits that a separate and optional maximization operation is responsible for the maximal readings we (sometimes) perceive with *fewer than n* as well as with bare numerals (cf. Kennedy, 2013, 2015). Specifically, maximality is taken to be part of the meanings of numerals and numerical traces, so that a numeral *n* may not only be interpreted (as before) as a degree or as an intersective adjective ($n_{\texttt{isCard}}$), but also as a generalized quantifier over degrees, notated here by $n_{\texttt{isMax}}$, which denotes the set of all degree predicates whose maximum is equal to *n*.

(21) $[\![n_{\texttt{isMax}}]\!] = \lambda P_{dt} . \max(P) = [\![n]\!]$

This approach allows us to derive both maximal (or 'exactly', or 'two-sided') and non-maximal (or 'at least', or 'one-sided') readings of bare numerals (in distributive contexts), depending on whether the numeral *n* is interpreted as $n_{\texttt{isMax}}$ or as $n_{\texttt{isCard}}$, respectively (see Spector 2013 for a survey of the issues). For example, (22) receives two different parses, depending on how *three* is interpreted.

(22)   Three students attended.

(23)   a.   [∅∃ [three$_{\texttt{isCard}}$ students]] attended
        b. $\exists x [\#x = 3 \wedge \textbf{students}(x) \wedge \textbf{attended}(x)]$
        c.   'At least three students attended.'

(24)   a.   three$_{\texttt{isMax}}$ [λn [[∅∃ [$n_{\texttt{isCard}}$ students]] attended]]
        b. $\max(\lambda n . \exists x [\#x = n \wedge \textbf{students}(x) \wedge \textbf{attended}(x)]) = 3$
        c.   'Exactly three students attended.'

Since maximality is considered a separate component (part of the meaning of numerals and numerical traces), *fewer than four* simply makes an existential statement about degrees.

(25) $[\![\text{fewer than four}]\!] = \lambda P_{dt} . \exists n [n < 4 \wedge P(n)]$

For the moment, let us continue to assume that, even on the SMax approach, existential force is contributed by the silent determiner ∅∃ (we return to this assumption in section 5.2). Then, for a sentence of the form *Fewer than four NP VP*, there are four LFs to consider, depending on (i) the relative scope of *fewer than four* and ∅∃, and (ii) whether or not maximization applies. When *fewer than four* scopes above ∅∃, and its numerical trace *n* is *not* interpreted as $n_{\texttt{isMax}}$, we get a non-maximal (existential) reading. Just like for LMax, this reading is appropriate (and not blocked) for a sentence like (3a) with a non-distributive predicate, and for a sentence like (1a) with a distributive predicate, this reading is blocked by the constraint in (10).

(26)   a.   [fewer than four] $[\lambda n \: [[\varnothing_{\exists} \: [n_{\texttt{isCard}} \: \text{NP}]] \: \text{VP}]]$

          b. $\exists n[n < 4 \land \exists x[\#x = n \land [\![\text{NP}]\!](x) \land [\![\text{VP}]\!](x)]]$

              $\equiv \exists x[\#x < 4 \land [\![\text{NP}]\!](x) \land [\![\text{VP}]\!](x)]$

When *fewer than four* scopes above $\varnothing_{\exists}$, and its numerical trace *n is* interpreted as $n_{\texttt{isMax}}$ (which itself must also move), then we get a maximal reading, which is appropriate for a sentence like (1a) with a distributive predicate.

(27)   a.   [fewer than four] $[\lambda n \: [n_{\texttt{isMax}} \: [\lambda m \: [\: [\varnothing_{\exists} \: [m_{\texttt{isCard}} \: \text{NP}]] \: \text{VP}]]]]$

          b. $\exists n[n < 4 \land \max(\lambda m \: . \: \exists x[\#x = m \land [\![\text{NP}]\!](x) \land [\![\text{VP}]\!](x)]) = n]$

              $\equiv \max(\lambda m \: . \: \exists x[\#x = m \land [\![\text{NP}]\!](x) \land [\![\text{VP}]\!](x)]) < 4$

SMax therefore need not rely on scope ambiguity to generate both types of readings (maximal and non-maximal). Moreover, it turns out that allowing *fewer than four* to scope below $\varnothing_{\exists}$, with or without maximization, does not generate any new readings. Specifically, when *fewer than four* scopes below $\varnothing_{\exists}$, and maximization does *not* apply, we get the non-maximal (existential) reading.

(28)   a. $[\varnothing_{\exists} \: [[_{\text{AP}} \: \lambda x \: [[\text{fewer than four}] \: [\lambda n \: [x \: n_{\texttt{isCard}}]]]] \: \text{NP}]] \: \text{VP}$

          b. $\exists x[\exists n[n < 4 \land \#x = n] \land [\![\text{NP}]\!](x) \land [\![\text{VP}]\!](x)]$

              $\equiv \exists x[\#x < 4 \land [\![\text{NP}]\!](x) \land [\![\text{VP}]\!](x)]$

And when *fewer than four* scopes below $\varnothing_{\exists}$, and maximization *does* apply, it applies vacuously (cf. (20)), and we again get the non-maximal (existential) reading.

(29)   a. $[\varnothing_{\exists} \: [[_{\text{AP}} \: \lambda x \: [[\text{fewer than four}] \: [\lambda n \: [n_{\texttt{isMax}} \: [\lambda m \: [x \: m_{\texttt{isCard}}]]]]]] \: \text{NP}]] \: \text{VP}$

          b. $\exists x[\exists n[n < 4 \land \max(\lambda m \: . \: \#x = m) = n] \land [\![\text{NP}]\!](x) \land [\![\text{VP}]\!](x)]$

              $\equiv \exists x[\exists n[n < 4 \land \#x = n] \land [\![\text{NP}]\!](x) \land [\![\text{VP}]\!](x)]$

              $\equiv \exists x[\#x < 4 \land [\![\text{NP}]\!](x) \land [\![\text{VP}]\!](x)]$

Importantly, although SMax generates a greater number of LFs than LMax does, it generates exactly the same set of readings for the sentences discussed so far. The reason is that the existential quantifier (over individuals) of $\varnothing_{\exists}$ and the existential quantifier (over degrees) of *fewer than four* commute. As a result, (26) and (28) are equivalent. Moreover, given fact (20), it follows that (28) and (29) are equivalent. Thus, (26), (28), and (29) are all equivalent, and are in turn equivalent to LMax's (17). If, however, we can find a case where commutativity between *fewer than four* and the null determiner does not arise, then we might be able to distinguish SMax from LMax.

3. Evidence from genericity

We now move to generic (more specifically, characterizing) sentences, which involve a kind of quasi-universal force, rather than existential force. We will see that the commutativity observed above in the existential domain does not arise for quasi-universally interpreted sentences containing *fewer than n*. As a result, SMax will turn out to generate a reading which LMax cannot, and which, I claim, is indeed the salient reading we want to capture. I start with a very simple description and theory of basic characterizing sentences, followed by an extension to characterizing sentences with bare numerals, and finally to characterizing sentences with numerals modified by *fewer than*.

3.1. Basic characterizing sentences

Sentence (30) is a CHARACTERIZING, or generalizing, or simply generic, sentence (Krifka et al., 1995): it expresses a generalization of some kind (in this case, about cats).

(30)   Cats have fur.

In particular, (30) means something like 'Any/every typical cat has fur'. I will represent this reading as follows, where '$\forall_{\text{Gen}}$' should be understood as a kind of restricted universal quantifier, which quantifies over all 'typical' individuals (of some sort or other).[9]

(31) $\forall_{\text{Gen}}x[\textbf{cats}(x) \rightarrow \textbf{have\_fur}(x)]$

Note that, since *cats* and *have fur* both have distributive reference, the postulated meaning ('Any (typical) group of cats has the property of having fur') entails that any (typical) individual cat has fur, as desired. We can capture this reading on analogy with existential indefinites simply by positing a silent generic determiner, $\varnothing_{\text{Gen}}$, as shown below.[10]

(32) $[\![\varnothing_{\text{Gen}}]\!] = \lambda P_{et} \,.\, \lambda Q_{et} \,.\, \forall_{\text{Gen}}x[P(x) \rightarrow Q(x)]$

(33)   a. $[\varnothing_{\text{Gen}} \text{ cats}] \text{ [have fur]}$
           b. $\forall_{\text{Gen}}x[\textbf{cats}(x) \rightarrow \textbf{have\_fur}(x)]$

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[9]I leave open the question of how exactly $\forall_{\text{Gen}}$ is interpreted, and in particular what it means for an individual to be 'typical'. See Krifka et al. (1995) for a survey of a number of proposals, any one of which could be employed here. The exact treatment of $\forall_{\text{Gen}}$, in particular how exceptions are allowed for, is an important issue in the semantics of genericity, but is, as far as I can tell, not very important for the analysis of *fewer than* (though see footnotes 13 and 15). As I hope the reader will see, all that seems to matter for the issues at hand is that $\forall_{\text{Gen}}$ is non-existential.

[10]The generic operator should probably really be a sentential operator. The choice of making it a quantificational determiner is simply to make the discussion here as close as possible to that of existential numerical indefinites, where I posited a silent existential determiner, $\varnothing_{\exists}$. As far as I can tell, everything I will say is compatible with a sentential generic operator, provided that quantifiers like *fewer than four* may scope above the operator (see section 4.2).

3.2. Characterizing sentences with bare numerals

Characterizing sentences with bare numerals appear to work exactly as expected: (34), taken from Link (1987), expresses the generalization that any typical group of three men can lift the piano.

(34)   Three men can lift the piano.   (Link, 1987)

This reading falls out naturally from the adjectival analysis of numerals and the null determiner analysis of genericity developed so far.[11]

(35)   a. $[\varnothing_{\text{Gen}} \, [\text{three}_{\texttt{isCard}} \, \text{men}]] \, [\text{can lift the piano}]$
         b. $\forall_{\text{Gen}} x [[\#x = 3 \wedge \textbf{men}(x)] \rightarrow \textbf{can\_lift}(x)]$

As an important side remark, the reader may wonder whether the characterizing reading of (34) should instead be represented by an LF where the modal *can* takes wide scope and the propositional argument of the modal has existential force, as shown below.

(36)   a.   can $[[\varnothing_{\exists} \, [\text{three}_{\texttt{isCard}} \, \text{men}]] \, [\text{lift the piano}]]$
         b. $\Diamond \exists x [\#x = 3 \wedge \textbf{men}(x) \wedge \textbf{lift}(x)]$

This interpretation can be paraphrased as 'There is an accessible world *w* such that, in *w*, there is a group of three men who lift the piano'. I have three arguments against such an analysis.

First, and perhaps most importantly, the interpretation derived on this analysis is too weak to represent the quasi-universality of the characterizing reading of (34). On its characterizing reading, (34) entails that if, say, Al, Bill, and Carl are three men (of typical/average strength), then Al, Bill, and Carl can lift the piano. By contrast, (36) simply says that in *some* accessible world, there is *some* group of three men (perhaps three extraordinarily strong men, i.e. not necessarily Al, Bill, and Carl, who are only of average strength) who lift the piano.

Second, observe that weak negative polarity items (NPIs) are licensed inside of generically interpreted numerical nominals, as (37) illustrates. This observation is fully expected on the analysis in (35), because there *any* occurs in a downward-entailing environment, just like the restrictor of *every* (Ladusaw, 1979); however, it is not expected on the analysis in (36), because there *any* occurs in an upward-entailing environment.

(37)   Three men with any experience in the moving business can lift the piano.

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[11]This analysis is precisely the one that Link (1987) gives, too. However, his main concern in that paper is not the precise analysis of numerals or of genericity, but rather the search for what he calls 'genuine' (as opposed to 'spurious') plural quantification in natural language, an example of which is (34). He does not discuss characterizing sentences containing modified numerals.

Finally, note that (38a) is perfectly acceptable and interpretable, and presumably has a representation like (36) (with *can* replaced by *possible*). Crucially, (38a) is intuitively weaker than (34) (on its generic reading). Moreover, it fails to license weak NPIs. That (34) and (38a) differ intuitively both in meaning and in NPI licensing is strong evidence for different representations, along the lines of (35) and (36), respectively.

(38) a. It is possible for three men to lift the piano.
      b. It is possible for three men with {some / #any} experience in the moving business to
          lift the piano.

In sum, while (36) may represent one reading of (34), it does not represent what I, and Link (1987), take to be the characterizing reading of (34), which henceforth I assume involves wide-scope $\varnothing_{\text{Gen}}$, as in (35).[12]

3.3. Characterizing sentences with modified numerals

Finally, consider a characterizing sentence with *fewer than four*, modeled on (34).

(39)   Fewer than four men can lift the piano.

Sentence (39) appears to have available the reading given in (40).

(40) a. $\exists n[n < 4 \land \forall_{\text{Gen}}x[[\#x = n \land \mathbf{men}(x)] \to \mathbf{can\_lift}(x)]]$
      b. 'There is a number $n < 4$ such that, in general, any group of n men can lift the piano.'

This reading is most natural in a kind of 'speaker ignorance' context: it can be brought out by prepending to (39) something like *I'm not sure exactly how many men it takes, but I'm certain that . . . .* However, it is also natural in a dialog like the following.

(41)   A: We'd like to buy the piano, but we are only four people. Will we be able to lift it?
        B: Absolutely. In fact, fewer than four people can lift the piano.

Notice once again the lack of any reference to maximality in the representation in (40), despite the presence of *fewer than*. This reading is thus another kind of non-maximal reading, but let us refer more specifically to this reading as an INTERMEDIATE generic reading, for reasons that will soon become clear. As we will see, only SMax can generate this reading, namely by scoping *fewer than four* above $\varnothing_{\text{Gen}}$, and without applying maximization.[13]

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[12]For further discussion of these issues, see Buccola (2015a).

[13]We should ask ourselves whether (39) entails any lower bound or not. Recall from section 1 that in distributive existential cases, e.g. (1a) (*Fewer than four students attended*), there is no lower-bound entailment – only an implicature

4. Two theories revisited

We now revisit the LMax and SMax accounts to see what readings they predict for (39).

4.1. Lexical maximality revisited

Just as in the existential domain, the LMax account has two scope possibilities available, depending on the relative scope of *fewer than four* and $\varnothing_{\mathrm{Gen}}$. When *fewer than four* scopes above $\varnothing_{\mathrm{Gen}}$, we get what I will call a MAXIMAL generic reading.

(42)   a.   [fewer than four] $[\lambda n\ [[\varnothing_{\mathrm{Gen}}\ [n_{\mathtt{isCard}}\ \mathrm{NP}]]\ \mathrm{VP}]]$

        b. $\max(\lambda n\,.\,\forall_{\mathrm{Gen}}x[[\#x = n \wedge [\![\mathrm{NP}]\!](x)] \to [\![\mathrm{VP}]\!]) < 4$

And when *fewer than four* scopes below $\varnothing_{\mathrm{Gen}}$, we get what I will call a STRONG UNIVERSAL generic reading.

(43)   a. $[\varnothing_{\mathrm{Gen}}\ [[\lambda x\ [\text{fewer than four}]\ [\lambda n\ [x\ n_{\mathtt{isCard}}]]]\ \mathrm{NP}]]\ \mathrm{VP}$

        b. $\forall_{\mathrm{Gen}}x[[\max(\lambda n\,.\,\#x = n) < 4 \wedge [\![\mathrm{NP}]\!](x)] \to [\![\mathrm{VP}]\!](x)]$

           $\equiv \forall_{\mathrm{Gen}}x[[\#x < 4 \wedge [\![\mathrm{NP}]\!](x)] \to [\![\mathrm{VP}]\!](x)]$

Turning now to (39), the problem is that neither scope possibility yields the right reading; that is, neither the maximal reading nor the strong universal reading corresponds to the intermediate generic reading in (40). The maximal reading, for example, entails that it is not the case that, say, (any group of) four men can lift the piano, whereas the reading in (40) does not.

(44)   a.   [fewer than four] $[\lambda n\ [[\varnothing_{\mathrm{Gen}}\ [n_{\mathtt{isCard}}\ \text{men}]]\ [\text{can lift the piano}]]]$

        b. $\max(\lambda n\,.\,\forall_{\mathrm{Gen}}x[[\#x = n \wedge \mathbf{men}(x)] \to \mathbf{can\_lift}(x)]) < 4$

        c.   'The maximum number *n* such that, in general, any group of *n* men can lift the piano is less than 4.'

– whereas in non-distributive existential cases, e.g. (3a) (*Fewer than four students lifted the piano together*) and (5a) (*Fewer than four students drank more than twenty beers between them*), there is a lower-bound entailment. It seems to me that (39) *does* entail that there is some *non-zero* number *n* such that, in general, *n* people can lift the piano. For example, *Fewer than four babies can lift the piano* feels false (or, if true, then extremely surprising) in most normal contexts, just like *Fewer than four babies lifted the piano* does. Similarly, *Every piano can be lifted by fewer than four men* feels false if some pianos cannot be lifted at all. It is unclear whether the representation I have given in (40) predicts this lower-bound inference. If $\forall_{\mathrm{Gen}}$ is interpreted similarly to the standard quantifier $\forall$, then it would seem not to: choosing $n = 0$ renders the formula true, since the restrictor of $\forall_{\mathrm{Gen}}$ is false for all *x* (there is no *x* such that $\#x = 0$). My hope, however, is that a more sophisticated theory of genericity can handle this edge case. See Buccola (2015a) for further discussion, as well as footnote 15.

And the strong universal reading is strictly stronger than (40): it entails that (any group of) three men, two men, and even one man can lift the piano, whereas (40) does not.[14]

(45)   a. $[\varnothing_{\text{Gen}} \, [[\lambda x \, [[\text{fewer than four}] \, [\lambda n \, [x \, n_{\text{isCard}}]]]] \, \text{men}]] \, [\text{can lift the piano}]$
        b. $\forall_{\text{Gen}} x [[\#x < 4 \wedge \mathbf{men}(x)] \rightarrow \mathbf{can\_lift}(x)]$
        c.   'In general, any group of fewer than four men can lift the piano.'

I will address the question of whether maximal generic readings and strong universal generic readings are (ever) available in section 5. The point for now is that LMax is unable to generate the intermediate generic reading in (40), which I claimed to be an available reading of (39).

4.2. Separate maximality revisited

Just as in the existential domain, the SMax account has four possibilities, depending on (i) the relative scope of *fewer than four* and $\varnothing_{\text{Gen}}$, and (ii) whether or not maximization applies. When *fewer than four* scopes above $\varnothing_{\text{Gen}}$, and maximization does *not* apply, then we get the non-maximal, intermediate reading that we want for a sentence like (39).

(46)   a. $[\text{fewer than four}] \, [\lambda n \, [[\varnothing_{\text{Gen}} \, [n_{\text{isCard}} \, \text{NP}]] \, \text{VP}]]$
        b. $\exists n [n < 4 \wedge \forall_{\text{Gen}} x [[\#x = n \wedge [\![\text{NP}]\!]] \rightarrow [\![\text{VP}]\!](x)]]$

(47)   a. $[\text{fewer than four}] \, [\lambda n \, [[\varnothing_{\text{Gen}} \, [n_{\text{isCard}} \, \text{men}]] \, [\text{can lift the piano}]]]$
        b. $\exists n [n < 4 \wedge \forall_{\text{Gen}} x [[\#x = n \wedge \mathbf{men}(x)] \rightarrow \mathbf{can\_lift}(x)]]$
        c.   'There is a number $n < 4$ such that, in general, any group of n men can lift the piano.'

When *fewer than four* scopes above $\varnothing_{\text{Gen}}$, and maximization *does* apply, then we get a maximal reading. This is the same maximal reading that LMax derives when *fewer than four* scopes above $\varnothing_{\text{Gen}}$, i.e. (42).

(48)   a. $[\text{fewer than four}] \, [\lambda n \, [n_{\text{isMax}} \, [\lambda m \, [[\varnothing_{\text{Gen}} \, [m_{\text{isCard}} \, \text{NP}]] \, \text{VP}]]]]$
        b. $\exists n [n < 4 \wedge \max(\lambda m \, . \, \forall_{\text{Gen}} x [[\#x = m \wedge [\![\text{NP}]\!](x)] \rightarrow [\![\text{VP}]\!](x)]) = n]$
              $\equiv \max(\lambda m \, . \, \forall_{\text{Gen}} x [[\#x = m \wedge [\![\text{NP}]\!](x)] \rightarrow [\![\text{VP}]\!](x)]) < 4$

And when *fewer than four* scopes below $\varnothing_{\text{Gen}}$, then we get a strong universal reading, regardless of whether maximization applies, given once again the fact in (20). This is the same universal reading that LMax derives when *fewer than four* scopes below $\varnothing_{\text{Gen}}$, i.e. (43).

(49)   a. $[\varnothing_{\text{Gen}} \, [[\lambda x \, [[\text{fewer than four}] \, [\lambda n \, [x \, n_{\text{isCard}}]]]] \, \text{NP}]] \, \text{VP}$

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[14]I assume here that plural expressions like *men* contain both atomic and non-atomic individuals in their extension, but this assumption is not crucial: even without it, the derived reading is strictly stronger than (40) (cf. footnote 7).

b. $\forall_{\mathrm{Gen}} x \big[\big[\exists n [n < 4 \wedge \# x = n] \wedge [\![\mathrm{NP}]\!](x) \big] \rightarrow [\![\mathrm{VP}]\!] \big]$
    $\equiv \forall_{\mathrm{Gen}} x \big[\big[\# x < 4 \wedge [\![\mathrm{NP}]\!](x) \big] \rightarrow [\![\mathrm{VP}]\!](x) \big]$

(50) a. $[\varnothing_{\mathrm{Gen}}\ [[\lambda x\ [[\text{fewer than four}]\ [\lambda n\ [n_{\mathtt{isMax}}\ [\lambda m\ [x\ m_{\mathtt{isCard}}]]]]]]\ \mathrm{NP}]]\ \mathrm{VP}]$
      b. $\forall_{\mathrm{Gen}} x \big[\big[\exists n [n < 4 \wedge \max(\lambda m\,.\,\# x = m) = n] \wedge [\![\mathrm{NP}]\!](x) \big] \rightarrow [\![\mathrm{VP}]\!](x) \big]$
          $\equiv \forall_{\mathrm{Gen}} x \big[\big[\exists n [n < 4 \wedge \# x = n] \wedge [\![\mathrm{NP}]\!](x) \big] \rightarrow [\![\mathrm{VP}]\!] \big]$
          $\equiv \forall_{\mathrm{Gen}} x \big[\big[\# x < 4 \wedge [\![\mathrm{NP}]\!](x) \big] \rightarrow [\![\mathrm{VP}]\!](x) \big]$

Crucially, (46) (the intermediate reading) is not equivalent to (49) (hence, nor to (50)) because the existential degree quantifier of *fewer than four* and the quasi-universal individual quantifier of $\varnothing_{\mathrm{Gen}}$ do not commute. As a result, in the generic domain, SMax generates a reading that LMax does not, which also happens to be the salient reading of (39).

5. Extending the blocking account

5.1. Non-intermediate readings with *can lift the piano*

An immediate question that arises is: Are the two non-intermediate generic readings (i.e. the maximal reading and the strong universal reading) intuitively available for (39)? My answer is that these readings are intuitively *unavailable* to the extent that the inference in (51) is intuitively *valid*. It seems plausible to me that (51) is valid: the more men, the easier it is for them to lift the piano. If so, then, as I will now show, (the LFs corresponding to) the two non-intermediate readings are blocked by the pragmatic blocking constraint in (10), hence are expected to be unavailable.

(51) If *n* men can lift the piano, then so can *n* + 1 (for any *n* ≠ 0).

5.1.1. The maximal generic reading

For the maximal generic reading, given below, the set to which max applies is either empty, or it is non-empty, hence by (51) has no maximum. For the sentence to be true, then, it must be that there is no number *n* such that *n* men can lift the piano (otherwise, we get maximality failure). We derive this same reading if *four* is replaced, say, by *three* or by *five*; thus, it is blocked by the constraint in (10).

(52) $\max\big(\lambda n\,.\,\forall_{\mathrm{Gen}} x \big[[\# x = n \wedge \mathbf{men}(x)] \rightarrow \mathbf{can\_lift}(x) \big] \big) < 4$
      $\equiv \max\big(\lambda n\,.\,\forall_{\mathrm{Gen}} x \big[[\# x = n \wedge \mathbf{men}(x)] \rightarrow \mathbf{can\_lift}(x) \big] \big) < 3$
      $\equiv \max\big(\lambda n\,.\,\forall_{\mathrm{Gen}} x \big[[\# x = n \wedge \mathbf{men}(x)] \rightarrow \mathbf{can\_lift}(x) \big] \big) < 5$
      $\equiv \big[\lambda n\,.\,\forall_{\mathrm{Gen}} x \big[[\# x = n \wedge \mathbf{men}(x)] \rightarrow \mathbf{can\_lift}(x) \big] \big] = \varnothing$ BLOCKED

5.1.2. The strong universal generic reading

For the strong universal generic reading, given below, the validity of (51) leads to an even stronger reading: any group of men of *any* cardinality can lift the piano. This same reading is derived if *four* is replaced, say, by *three* or by *five*, hence is blocked.

$$(53) \qquad \forall_{\text{Gen}} x \big[[\#x < 4 \wedge \mathbf{men}(x)] \rightarrow \mathbf{can\_lift}(x) \big]$$
$$\equiv \forall_{\text{Gen}} x \big[[\#x < 3 \wedge \mathbf{men}(x)] \rightarrow \mathbf{can\_lift}(x) \big]$$
$$\equiv \forall_{\text{Gen}} x \big[[\#x < 5 \wedge \mathbf{men}(x)] \rightarrow \mathbf{can\_lift}(x) \big]$$
$$\equiv \forall_{\text{Gen}} x \big[\mathbf{men}(x) \rightarrow \mathbf{can\_lift}(x) \big] \qquad\qquad \text{BLOCKED}$$

5.2. A prediction: *can fit into the elevator*

The view espoused above leads to the following prediction: if the assumption in (51) is invalid, then maximal and strong universal generic readings should be available. Again, it is plausible to me that (51) is valid, but if we move instead to a predicate like *can fit into the elevator*, then the analogous inference is clearly invalid: if n people can fit into the elevator, then it is not necessarily the case that $n + 1$ people can fit into the elevator. In fact, the opposite inference (viz. that $n - 1$ people can fit), given in (54), is valid.

(54)   If n people can fit into the elevator, then so can $n - 1$ (for any $n > 1$).

As a result, a blocking account predicts that a sentence like (55) should have both a maximal generic reading and a strong universal reading (and no intermediate generic reading), as I now show.

(55)   Fewer four people can fit into the elevator.

5.2.1. The maximal generic reading

Assuming that (54) is intuitively valid, then the maximal reading of (55), given below, does not give rise to any maximality failure, hence is not blocked by the constraint in (10). Indeed, the most salient reading of (55) is the predicted maximal reading, which states that the maximum number of people who can fit into the elevator is less than 4.[15]

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[15]Note that, just like maximal reading of a distributive existential sentence like (1a) (*Fewer than four students attended*), the maximal generic reading of (55) is intuitively compatible with no people being able to fit. To the extent that (55) implies that at least one person can fit, I take this to be a pragmatic inference analogous to inference we normally draw from (1a) that at least some student(s) attended. Importantly, however, it is not at all clear how to reconcile this observation with the observation that the intermediate generic reading of (39) (*Fewer than four men can lift the piano*) is *not* compatible with no men being able to lift the piano (see footnote 13). See Buccola (2015a) for further discussion.

(56) $\max(\lambda n \,.\, \forall_{\text{Gen}} x[[\#x = n \land \textbf{people}(x)] \rightarrow \textbf{can\_fit}(x)]) < 4$
         $\not\equiv \max(\lambda n \,.\, \forall_{\text{Gen}} x[[\#x = n \land \textbf{people}(x)] \rightarrow \textbf{can\_fit}(x)]) < 3$
         $\not\equiv \max(\lambda n \,.\, \forall_{\text{Gen}} x[[\#x = n \land \textbf{people}(x)] \rightarrow \textbf{can\_fit}(x)]) < 5$ ✓

5.2.2. The strong universal generic reading

In addition, the strong universal generic reading is not blocked: replacing *four* with *three* yields a weaker meaning, and replacing *four* with *five* yields a stronger meaning.

(57) $\forall_{\text{Gen}} x[[\#x < 4 \land \textbf{people}(x)] \rightarrow \textbf{can\_fit}(x)]$
         $\not\equiv \forall_{\text{Gen}} x[[\#x < 3 \land \textbf{people}(x)] \rightarrow \textbf{can\_fit}(x)]$
         $\not\equiv \forall_{\text{Gen}} x[[\#x < 5 \land \textbf{people}(x)] \rightarrow \textbf{can\_fit}(x)]$??/NOT BLOCKED

It is unclear to me whether this reading is indeed available. Note that it is also compatible with (any group of) four, five, ... people being able to fit. If this reading is unavailable, then the SMax account could probably be modified so that *fewer than four* never scopes below $\varnothing_{\text{Gen}}$ (or $\varnothing_{\exists}$[16]). One way to achieve this would be to replace $\varnothing_{\exists}$ and $\varnothing_{\text{Gen}}$ by the silent counting quantifiers $\langle many_{\exists} \rangle$ and $\langle many_{\text{Gen}} \rangle$ below, inspired by Hackl (2000).

(58)   a. $[\![\langle \text{many}_{\exists} \rangle]\!] = \lambda n_d \,.\, \lambda P_{et} \,.\, \lambda Q_{et} \,.\, \exists x[\#x = n \land P(x) \land Q(x)]$
         b. $[\![\langle \text{many}_{\text{Gen}} \rangle]\!] = \lambda n_d \,.\, \lambda P_{et} \,.\, \lambda Q_{et} \,.\, \forall_{\text{Gen}} x[[\#x = n \land P(x)] \rightarrow Q(x)]$

The idea here is that, since $\langle many_{\exists} \rangle$ and $\langle many_{\text{Gen}} \rangle$ must first combine with a degree-denoting expression (a numeral or numerical trace), it is impossible for *fewer than four* to ever scope below them, i.e. to quantify into AP (or NP). More precisely, while an LF like (59a) is interpretable, an LF like (59b) is uninterpretable: $\langle many \rangle$ (which here stands ambiguously for $\langle many_{\exists} \rangle$ or $\langle many_{\text{Gen}} \rangle$) requires an argument of type d, but is instead combining with an expression of type et, namely the intersection of the numerical AP and the NP.

(59)   a.   [fewer than four] [λn [[[$n \langle \text{many} \rangle$] NP] VP]]
         b.   [$\langle \text{many} \rangle$ [[$_{\text{AP}}$ λx [[fewer than four] [λn [x n_{isCard}]]]] NP]] VP

5.2.3. The intermediate generic reading

Finally, (55) is predicted not to have a non-maximal, intermediate generic reading: in this case, because of (54), we get an extremely weak reading, which simply states that some number of people

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    [16]Recall that SMax does not need to rely on scope ambiguity to generate both maximal and non-maximal readings in the existential domain: scoping *fewer than four* below $\varnothing_{\exists}$ yields the same non-maximal, existential reading as scoping *fewer than four* above $\varnothing_{\exists}$ does, without applying maximization, given the commutativity of the existential degree quantifier of *fewer than four* and the existential individual quantifier of $\varnothing_{\exists}$.

can fit into the elevator; the numeral *four* makes no semantic contribution. The logic of this result is exactly the same as that of Van Benthem's problem in the existential domain for distributive predicates, except that here the downward inferences that lead to the result are due to (54) rather than to distributivity.[17] This appears to be a welcome result, as (55) does not seem to have this weak reading.

(60) $\exists n[n < 4 \wedge \forall_{\text{Gen}} x[[\#x = n \wedge \textbf{people}(x)] \rightarrow \textbf{can\_fit}(x)]]$
       $\equiv \exists n[n < 3 \wedge \forall_{\text{Gen}} x[[\#x = n \wedge \textbf{people}(x)] \rightarrow \textbf{can\_fit}(x)]]$
       $\equiv \exists n[n < 5 \wedge \forall_{\text{Gen}} x[[\#x = n \wedge \textbf{people}(x)] \rightarrow \textbf{can\_fit}(x)]]$ BLOCKED

6. Conclusion

I've presented evidence from genericity suggesting that maximality should be separate from the meaning of *fewer than*. That is, reliance on scope ambiguity (LMax) is not enough to generate the range of attested readings of sentences involving *fewer than*. On this view, *fewer than four* is not really a downward-entailing operator. Rather, downward-entailing environments are created under very specific (albeit very common) conditions: namely, when *fewer than four* takes wide scope and its numerical trace n is interpreted as n_{isMax}. Moreover, the application of maximality is regulated by a pragmatic constraint that is sensitive to the types of inferences that predicates allow. This explains why the availability of maximal vs. non-maximal readings is only partially related to whether we are in an existential vs. generic context, or whether we have a distributive vs. non-distributive predicate. Finally, we discover that Van Benthem's problem is more pervasive than we once thought, and that the (extremely weak) readings that it gives rise to always seem to be inaccessible.

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[17]Of course, the intuitive validity of (54) probably has something to do with the distributivity of *fit into the elevator*.

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Homogeneity and the Mass/Count Distinction[1]

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Abstract. Predominantly count nouns can have a mass form. The universal grinder proposed by Pelletier (1975) for the semantics of mass forms of predominantly count nouns have been widely adopted. However, I argue that grinding is not part of the semantics; instead, it is an implicature triggered by formal atomlessness encoded in mass forms. This proposal is in accordance with the observation that the mass/count distinction concerns the way nominals refer, rather than the structures of referents. However, the felicity of using the mass form of a predominantly count noun can be influenced by the homogeneity of the referents.

Keywords: formal atomlessness, homogeneity, mass/count.

1. Introduction

In many languages such as English and German, there are a variety of properties that characterize the grammatical mass/count distinction, namely, the distinction between mass nouns and count nouns. For instance, the following properties are among the best known:

- restriction of plural morphology to count nouns;

    (1)   a. The computer is connected to two devices.

              b. * The computer is connected to two equipments.

- distribution of determiners;

    (2)   a. much snow/*chair, little snow/*chair

              b. many planes/*rice, every plane/*rice

- eligibility of associating with numerals with/without intermediate classifiers.

    (3)   a. two tables / *two furniture(s)

              b. two pieces of furniture / *two pieces of table

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Although the mass/count distinction is primarily characterized by various grammatical properties, it is also deeply encoded in the semantics of nominals. The semantic representation of a count noun essentially differs from that of its mass counterpart even if they have the same noun stem (e.g., **rock**, **rope**). This claim is evidenced by the test based on comparative constructions. Barner and Snedeker (2005) discover that when people are asked to make a comparison concerning quantity of objects, they are inclined to exploit different types of information, depending on whether it is grammatically a mass noun or a count noun that is at issue.

For instance, the plural form **rocks** can denote the same physical objects as does the mass use of **rock** in many situations. However, sentence (4a) is evaluated with respect to number of individuals in contrast with (4b)'s being evaluated according to volume, even if people are shown the same scenario.

> (4)   a. John has more rocks than Mary does.
>   b. John has more rock than Mary does.

Despite the fact that most count nouns denote entities which consist of salient units or atoms while mass nouns mostly denote entities having no salient atoms, the exceptions are too many to be disregarded, such as **furniture** and **equipment**. Particularly, the mass/count distinction can be independent of the structures of objects. Specifically, a count noun can be nearly synonymous to a mass noun (Chierchia 1998: 56), as is illustrated by (5). Therefore, it is reasonable to assume that the mass/count distinction concerns the way objects are referred to, but not the presence/absence of their atomic structures (Rothstein 2010).

> (5)   shoes vs. footwear

What makes the mass/count distinction more interesting is the conversion between the two types of nouns. Sentence (6a) illustrates the count use of a mass noun. An utterance of (6a) is acceptable in a bar where the quantity of "a" water is publicly known, that is, usually a glass of water, though (6a) is not perfectly grammatical by default. In other words, sentence (6a) is a short version of (6b).

> (6)   a. Can I have a water?
>   b. Can I have a glass of water?

A count noun can also have mass use. For instance, sentence (7) is another way of saying that the ingredients for making the cake include bananas.

> (7)   There is banana in the cake.

This article is devoted to investigation of the latter type of conversion. It has been widely noticed that it is usually infelicitous to refer to objects falling under the denotation of a predominantly count noun $\mathbf{N_{count}}$ by its mass form $[\mathbf{N_{count}}]_{\mathbf{mass}}$. For example, sentence (8) is infelicitous if what is on the floor is a brand new bicycle. The felicity could be significantly enhanced if the scenario in question contains fragments of a disassembled bicycle on the floor.

(8)   There is bicycle all over the floor.

Based on such phenomena, atomic objects denoted by $\mathbf{N_{count}}$ are strictly excluded from the denotation of $[\mathbf{N_{count}}]_{\mathbf{mass}}$ in many, if not all, existing analyses (Cheng et al. 2008, Rothstein 2010). This line of thoughts could be traced back to Pelletier 1975 and Pelletier and Schubert 1989, who introduced the so-called *universal grinder* (to be reviewed in Section 3).

However, I argue that the exclusion of atomic $\mathbf{N}$s from $[\mathbf{N_{count}}]_{\mathbf{mass}}$ is not part of the semantics of $[\mathbf{N_{count}}]_{\mathbf{mass}}$. Instead, it is an implicature which is tightly bound with $[\mathbf{N_{count}}]_{\mathbf{mass}}$. This proposal is also in line with the observation that the mass/count distinction concerns the way objects are referred to, but not the presence/absence of their atomic structures (Rothstein 2010).

In the next section, I will introduce two distinct representations of aggregations, which underlie the semantic representations of the mass/count distinction in general. In Section 3, I will briefly review the proposal of the universal grinder and provide evidence against encoding natural atomlessness in the semantics. In Section 4, I will (i) present my analysis of $[\mathbf{N_{count}}]_{\mathbf{mass}}$'s preference for natural atomlessness (illustrated by (8)) in terms of formal atomlessness and (ii) account for the variation in felicity of using $[\mathbf{N_{count}}]_{\mathbf{mass}}$ across categories of nouns based on my refined definition of homogeneity.

2.   Formal Semantics of the Mass/Count Distinction

2.1.   Two Types of Aggregation

As a core constituent of analyses of the mass/count distinction, it has always been under debate how to represent aggregations that are involved in the semantics of nominals. A nominal in a natural language may denote an aggregation of multiple entities in a situation. For instance, in a scenario where Frege and Russell are the only logicians, sentence (9) can have such a reading that Frege and Russell are the authors of a single paper, whereas the most prominent interpretation of (10) is that Frege wrote a paper and Russell wrote another. Still, sentence (10) could serve as a paraphrase of (9) under another possible interpretation of the latter.

(9)   The logicians wrote a paper.
(10)   Frege wrote a paper and Russell wrote a paper.

Therefore, the denotation of the plural definite description **the logicians**, in the scenario at issue, should be represented as an aggregation in which the individual components are still grammatically accessible. That is, ⟦**the logicians**⟧ displays dual properties: the unity of the aggregation and the respective grammatical accessibility of individual components Frege and Russell. This duality is evidenced by the fact that the predicate of (9) can be applied to either the aggregation as a whole (i.e., the logicians collaborate as a group) or to the individuals constituting the aggregation (i.e., the logicians each write a paper).

There have been a number of competing proposals for the representation of aggregations that fall under the denotations of plural nominals, such as *group* (Landman 1989), *set* (Chierchia 1998) and *plurality* (Nicolas 2008). It is not the focus of this article to contribute to this debate on representation of aggregations; instead, what matters is that the representation of denotations of plural nominals displays the formal duality indicated by the semantic ambiguity of sentences such as (9). Particularly, the formal representation should preserve the respective grammatical accessibility of components of an aggregation.

Following Nicolas (2008), I assume that plural noun phrases denote *pluralities*. Formally, Frege ⊔ Russell is the plurality consisting of exactly Frege and Russell. Also, Frege⊔Russell represents the denotation of the noun phrase **Frege and Russell** where ⟦**Frege**⟧ = Frege and ⟦**Russell**⟧ = Russell. More generally, the plurality comprised of a set S of entities is denoted by $\bigsqcup S$. Moreover, let $\trianglelefteq$ denote the relation of *among* between pluralities and their components. Formally,

$$a \trianglelefteq b \ \text{ iff } \ \exists A[a \in A \wedge b = \bigsqcup A]$$

In contrast with pluralities, *mereological sum* or *fusion* essentially comes with unity but not multiplicity.[2] For example, the fusion of a and a' (notation: $a \oplus a'$) is used to represent the aggregation of a and a' as a single entity without visible inner structure, though possibly physically discrete (e.g., a does not overlap with a'). Formally, the unity of $a \oplus a'$ can be formulated as (11), which says that nothing is among a fusion except for the fusion itself.

(11) $\forall d[d \trianglelefteq a \oplus a' \rightarrow d = a \oplus a']$

Mereological sums or fusions comprise the denotations of mass noun phrases, as is illustrated by (12) which is seldom, if not never, considered as a well-formed sentence, even if there are multiple portions of water in question.

(12) *The water is connected to each other.

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[2]See Champollion and Krifka 2014 for an axiomatic characterization of *sum*.

Although it is also rather controversial what constraints antecedents of reciprocals are subject to, it is generally agreed that the antecedent NP should denote an aggregation of multiple entities that are respectively grammatically accessible. This constraint is also justified by the ungrammaticality of (13) in which the reciprocal has a singular count noun phrase as its antecedent. The ungrammaticality of (12) naturally follows from this constraint if it is assumed that the denotations of mass NPs consist of fusions, in which no proper part is individually visible. Specifically, the denotation of **the water** in (12) is represented as a single entity whose inner structure (e.g., consisting of multiple portions of water) is invisible to the semantic derivation.

(13)   *The chair is piled on top of each other.

Let $\leq$ denote the relation *(mereological) part-of*, which can be defined in terms of sum/fusion as follows.

$$a \leq b \text{ iff } a \oplus b = b$$

Moreover, a is a *proper part of* b (notation: $a < b$) iff $a \leq b$ and $a \neq b$. A simple example illustrating the difference between *among* and *part-of* is as follows. Let a and b be two chairs and a' a leg of a. Then, a' stands in the mereological part-of relation $\leq$ to a as well as to $a \oplus b$, formally, $a' \leq a$ and $a' \leq a \oplus b$. In contrast, *among* $\trianglelefteq$ holds between a and $a \sqcup b$ but not between a' and a or between a' and $a \sqcup b$. More generally, $\leq$ is transitive while $\trianglelefteq$ is not.

Two different pluralities can have the same mereological sum. For instance, the upper half of a glass of water and the lower half form a plurality that is not identical to the plurality formed by the left half and the right half, despite the mereological sums of the two pluralities being the same. As a consequence, mereological sum cannot be used to represent the aggregation formation denoted by conjunction. This can be illustrated by an example, which is similar to the one Landman (1989) uses to illuminate the distinction between sums and groups. If the subject NP of (14a) denotes the sum of the two halves of the water, which is exactly the entire portion of water contained in the glass, it would be expected that (14a) and (14b) entail each other, since the two sentences have semantically equivalent subject NPs. The semantic equivalence is obvious, given the fact that the sum of the left half and the right half of the water is also the entire portion of water in the glass. The mutual entailment between (14a) and (14b) is incompatible with the intuition that one of them can be true without the truth of the other.

(14)   a. The upper half of the water and the lower half are separated.
        b. The left half of the water and the right half are separated.

Therefore, it is pluralities, rather than mereological sums, that comprise the denotations of plural definite descriptions.

2.2. Mass/Count: A Typal Distinction

Given the assumption that mass NPs and count NPs denote aggregations represented with different operators, it still needs to be answered: what underlies the characteristic properties of the mass/count distinction such as restriction of plural morphology and distribution of determiners? Many of these properties are apparently orthogonal to the distinction regarding representation of aggregations. For instance, the interpretations of neither mass nouns nor singular count nouns could plausibly involve pluralities, whereas only singular count nouns could be pluralized. Moreover, this contrast cannot be ascribed to the difference that the denotations of mass nouns include mereological sums of multiple entities while those of singular count nouns exclusively consist of individuals, i.e., an aggregation/singularity contrast. The infeasibility of such a strategy follows from the notion of mereological sum. Specifically, an individual is the sum of all the parts of itself.

Therefore, it is reasonable to believe that the mass/count distinction is semantically based on contrastive properties in addition to the sum/plurality distinction. A plausible proposal comes from Rothstein 2010, in which it is fundamentally assumed that the mass/count distinction reflects the *typal* distinction of their denotations. Also, the threefold interpretation of noun stems proposed by Chierchia (2010) will be employed to formulate my analysis.

First of all, each noun stem **N** is associated with a *number-neutral* property N (Chierchia 2010). N is number-neutral, in the sense that it can contain both atomic **N**s (if there are) and sums of N-atoms. Specifically, N comes with a threefold interpretation:

(i)   a positive extension N_+ containing entities that definitely have the property of being N;

(ii)   a negative extension N_- consisting of entities that are definitely not N;

(iii)   a vagueness band $N_?$ of entities falling under neither N_+ nor N_-.

As an illustration, if a chair is cut bit by bit, there will come a point where it is no longer certain whether the remainder is still a chair. Formally, the remainder at that point falls under the vagueness band $CHAIR_?$.

The denotation of a mass noun **N$_{mass}$** is identical to the positive extension of the associated number-neutral property.

(15) $[\![\mathbf{N_{mass}}]\!] = N_+$

In contrast, the denotation of a count noun **N$_{count}$** consists of *count atoms* (Rothstein 2010: 363) that are of the form $\langle d, c \rangle$ where $d \in N_+$ and c is the context of the discourse.

(16) $[\![\mathbf{N_{count}}]\!] = \{\langle d, c \rangle : d \in N_{\mathrm{AT}}\}$

N_{AT} is the subset of N_+ that contains exactly the N-atoms. Different from Rothstein's (2010) definition, pluralization of count nouns is formulated in terms of plurality formation rather than in terms of mereological sums.

(17) $\mathrm{PL}([\![\mathbf{N}]\!]) = \begin{cases} \{\bigsqcup S : \emptyset \subsetneq S \subseteq [\![\mathbf{N}]\!]\} & \text{if } [\![\mathbf{N}]\!] \subseteq D \times \{c\} \\ \text{undefined} & \text{otherwise} \end{cases}$

The context index can serve a variety of purposes. For instance, the exact division between the three divisions of each number-neutral N is dependent on the particular c (Chierchia 2010: 117). Specifically, it varies across contexts where the borderline between N_+ and $N_?$ is. In the case of chair cutting, it is usually infeasible to provide a uniform criterion to precisely distinguish N_+-elements from those contained in $N_?$. In the framework of Rothstein 2010, context also plays the role of type marker. As is represented by (15) and (16), assume that D is the domain for the interpretation of number-neutral properties associated with noun stems, each $\mathbf{N_{mass}}$ is a subset of D that is directly adopted from the positive extension N_+; whereas $\mathbf{N_{count}} \subseteq D \times \{c\}$. The typal distinction is mainly employed to account for various characteristic properties of the mass/count distinction, such as restriction of plural morphology to singular count nouns and distribution of determiners (Rothstein 2010). Such a strategy could be instantiated by (17).

Despite the assumption of a typal distinction underlying the mass/count distinction, it is still necessary to have two types of representation of aggregations. However, it is not the focus of this article to argue against Rothstein's (2010) analysis in which various properties of the mass/count distinction is explained in terms of the mere typal distinction.[3]

To sum up, the mass/count distinction displays a large variety of properties that point toward both multiple representations of aggregations and a typal difference between mass nouns and count nouns. Particularly, the former concerns the grammatical (in)accessibility of components of aggregations, as is evidenced by the presence/absence of a distributive reading and the grammaticality of reciprocal constructions.

3. Against the Universal Grinder

As has been noted, transformation between mass nouns and count nouns occurs from time to time. Such transformation usually comes with constraints on the context. For instance, an utterance of (6a) (repeated below as (18)) is felicitous and grammatical only if it is clear in the context what

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[3]For such an argument based on the semantics of reciprocals, see Cai 2016.

counts as *a water*. In a restaurant or a bar, **a water** usually denotes a portion of water that is contained in a glass which has a uniform shape and volume.

(18)   Can I have a water?

This instantiates the count form of a predominantly mass noun. As for the opposite direction, which is instantiated by (8) (repeated below as (19)), Pelletier (1975) proposes the well-known *universal grinder* (20), based on the observation that (19) is infelicitous if there are only whole bicycles on the floor that are not disassembled.

(19)   There is bicycle all over the floor.

(20)   "Take an object corresponding to any (apparent) count noun he wishes (e.g., 'man'), put the object in one end of the grinder and ask what is on the floor (answer: There is man all over the floor). ...this test can be employed at will, always giving us a mass sense of count nouns having physical objects as their extension." (Pelletier 1975: 456)

The grinding proposal is widely interpreted as saying that the mass form $[\mathbf{N_{count}}]_{\mathbf{mass}}$ only denotes fragments of or stuff made from individuals falling under $[\![\mathbf{N_{count}}]\!]$, while atomic **N**s are precluded from the denotation of the mass form (Cheng et al. 2008, Rothstein 2010). A possible version of formalization is as (21).

(21) $[\![[\mathbf{N_{count}}]_{\mathbf{mass}}]\!] = \{x : \exists y[y \in N_{\mathrm{AT}} \land x < y]\}$

In other words, the core of the grinding approach is the semantically encoded *natural atomlessness*, in the sense that only fragments of atoms, but not whole atoms, are allowed for, which appears to capture the intuition about mass forms of predominantly count nouns. In addition, the grinder is claimed to be *universal*. That is, it should be applicable to any count nouns.

However, neither the universality nor the natural atomlessness is tenable if more data are scrutinized. For instance, the grinder apparently does not apply to group nouns such as **family**, **team** and **legion**. Specifically, a situation can hardly be found in which it is felicitous to utter (22).

(22)   *There is team all over the floor.

It is widely agreed that the denotations of group nouns are composed of composite atomic objects, which are often named *groups* (Chierchia 1998, Rothstein 2010). For instance, a football team by

default is formed by multiple players who act as a unit in games. Despite the preservation of grammatical accessibility of components contained in a group (as is evidenced by the grammaticality of (23)), groups are also atoms and can serve as units of grammatical counting, such as **two families**. Therefore, group nouns can be employed to talk about multiple entities as a countable unit or atom.

(23)   The family is supporting each other.

Hence, the ill-formedness of sentence (22) could be understood as a consequence of two contradictory operations. The first one is generating a composite atom (i.e., a team) out of the components (i.e., the individual members of the team) by using the group noun **team**. This operation could be considered as *atom generating*, which is incompatible with the co-occurring operation of *deatomization* via conversion of the group noun **team** into its mass form. The atom generating operation indicates that the speaker intends to refer to the team as a unit, whereas the deatomization operation displays the speaker's intention of talking about the aggregation of team members as being atomless. As could be expected, the two operations conflict with each other.

What is more problematic with the grinder approach is its strict exclusion of atomic entities from $[\![\mathbf{N_{count}}]_{\mathbf{mass}}]\!]$. If it is really the case that atomic entities are excluded from the semantics of mass forms of predominantly count nouns, it would be uniformly bad to denote aggregations of N-atoms by $[\mathbf{N_{count}}]_{\mathbf{mass}}$. However, some informants think that it is not totally bad to use (24) to describe a pile of thousands of whole bananas. In addition, this is also the case for other names of fruits and vegetables (e.g., **strawberry**, **tomato**). In contrast, such partial felicity is not available to names of artifacts (19).

(24)   The tower is made of banana.

In order to verify this contrast, a small survey was conducted on Ibex Farm with 99 native English speakers (based on self-identification) recruited via Mechanical Turk. Basically, the participants were instructed to evaluate the appropriateness of using the following sentences to describe the objects in question on a 5-point scale (with 1 point standing for *definitely inappropriate* while 5 for *definitely appropriate*). Each participant is randomly assigned one of the sentence-object pairs.

(25)   Sentence: The tower is made of chair.
        Object: A tower exclusively consisting of hundreds of whole chairs

(26)   Sentence: The tower is made of banana.
        Object: A tower exclusively consisting of thousands of whole bananas

(27)   Sentence: The pile is made of rock.
        Object: A pile of rocks

The results of Wilcoxon Rank Sum test ($W = 1138$, $p = .0178$) shows that the usage (26) ($N = 49$, $M = 3.59$, $SD = 1.29$) is noticeably more felicitous than that of (25) ($N = 36$, $M = 2.92$, $SD = 1.36$). Such a variation of felicity across nouns is unexpected if (21) properly represents the semantics of mass forms of predominantly count nouns, as the definition in itself does not allow for different degrees of violations given the fact that the objects in question, the chair tower and the banana tower, are both exclusively formed by atomic objects. The grinder metaphor cannot save the situation, either. There is no reason why whole bananas are more likely to survive the grinding operation and enter into the semantics of the mass form than are whole chairs.

What is probably even more surprising is the result concerning (27) ($N = 14$, $M = 3.93$, $SD = 1.14$), which fails to show that such usage of **rock**$_{\textbf{mass}}$ is more felicitous than **banana**$_{\textbf{mass}}$ in (26). However, as a grammatically flexible noun, **rock** has both a count form and a mass form by default. Particularly, there is nothing that prevents **rock**$_{\textbf{mass}}$ from containing ROCK-atoms in its extension. Take (28) as an example. It is clear that the material of which the Earth's outer solid layer is made does not exclude those pieces of rock which can count as *rocks*.

(28)   The Earth's outer solid layer is made of rock.

Formally, (sums of) ROCK-atoms also fall under $[\![$**rock**$_{\textbf{mass}}]\!]$, though they are not represented as count atoms of the form $\langle d, c \rangle$. Therefore, it is confusing to see the imperfect felicity of (27). Although this partial felicity does not directly constitute evidence against the grinder approach, it is argued to be in support of my analysis in Section 4.

In this section, preliminary empirical evidence has been presented which casts doubt on the soundness of the grinder proposal. Specifically, it is problematic to impose the constraint of natural atomlessness on the denotation of $[\mathbf{N_{count}}]_{\textbf{mass}}$. Furthermore, such a constraint seems to conflict with the general observation that the mass/count distinction concerns the way nominals refer, rather than the structures of the things they refer to.

4. The Uniformity of Mass Nouns

4.1. Formal Atomlessness

Despite the fact that it is probably infeasible to incorporate natural atomlessness into the semantics of $[\mathbf{N_{count}}]_{\textbf{mass}}$, it is true that $[\mathbf{N_{count}}]_{\textbf{mass}}$ is seldom used to denote aggregations of N-atoms, though partial felicity is possible (26). Therefore, it remains crucial to account for this phenomenon which has led to existing theories appealing to natural atomlessness on the semantic level. In this section, it is argued that a plausible account could be formulated in terms of the distinction of aggregation representation. That is, mereological sum vs. plurality.

As is observed in the survey, the imperfectness of (27) indicates that the inclusion of N-atoms in

the denotation of a mass noun $\mathbf{N_{mass}}$ does not guarantee the felicity of denoting aggregations of N-atoms by $\mathbf{N_{mass}}$. Together with the contrast between (25) and (26), this surprising phenomenon points toward, though does not entail, an origin of preference for natural atomlessness of denotations other than semantically encoded natural atomlessness.

Before looking for an exotic factor that could underlie the appropriateness judgments, it is helpful to search for potential origins within the framework adopted here. As is introduced in Section 2, two pairs of contrastive formal representations underlie the mass/count distinction and the semantics of nominals in general. One pair, sum vs. plurality, concerns representation of aggregations; while the other regards the typal difference between the denotations of mass nouns (uncountable entities from the domain D) and those of count nouns (i.e., count atoms of the form $\langle d, c \rangle \in D \times \{c\}$).

First of all, the second pair does not seem to have special effect on the mass forms $[\mathbf{N_{count}}]_{\mathbf{mass}}$ of predominantly count nouns $\mathbf{N_{count}}$ except that $[\![[\mathbf{N_{count}}]_{\mathbf{mass}}]\!]$ contains no count atoms. Particularly, the typal difference is not accountable for the infelicity of $[\mathbf{N_{count}}]_{\mathbf{mass}}$ denoting aggregations of N-atoms. For instance, there is such a subcategory of mass nouns, namely, *atomic mass nouns*, which denote entities with salient atomic structures, such as **furniture** and **equipment**. There are two equivalent ways to formulate the definition of $[\![\mathbf{furniture}]\!]$.

(29)   a. $[\![\mathbf{furniture}]\!] = \text{FURNITURE}_+$
        b. $[\![\mathbf{furniture}]\!] = \{\bigoplus S : \emptyset \subsetneq S \subseteq \text{FURNITURE}_{\text{AT}}\}$

The equivalence of (29a) and (29b) follows from the fact that only (aggregations of) individual pieces of furniture (i.e., FURNITURE-atoms), but not fragments of furniture, can be counted as furniture with certainty. That is, **furniture** normally denotes (aggregations of) FURNITURE-atoms rather than furniture fragments, though $[\![\mathbf{furniture}]\!]$ does not contain count atoms. Thus, the absence of count atoms cannot explain the infelicity of denoting aggregations of N-atoms by $[\mathbf{N_{count}}]_{\mathbf{mass}}$.

In addition to the absence of count atoms, pluralities are excluded from $[\![[\mathbf{N_{count}}]_{\mathbf{mass}}]\!]$. As an illustration, sentence (30) is ungrammatical even if the speaker is pointing at a pile of fragments of multiple bicycles.

(30)   *The bicycle is piled on top of each other.

It follows that the aggregations contained in $[\![[\mathbf{N_{count}}]_{\mathbf{mass}}]\!]$, if there are, are represented as mereological sums instead of pluralities. Nonetheless, it remains unsettled exactly what constitutes the denotation of $[\mathbf{N_{count}}]_{\mathbf{mass}}$. It has been shown that it is infeasible to exclude N-atoms from

$\llbracket [\mathbf{N_{count}}]_{\mathbf{mass}} \rrbracket$. Also, proper parts of N-atoms should be included, since $[\mathbf{N_{count}}]_{\mathbf{mass}}$ is most likely to denote N-fragments. Therefore, definition (31) is an plausible candidate.

(31) $\llbracket [\mathbf{N_{count}}]_{\mathbf{mass}} \rrbracket = \{d : d \leq \bigoplus N_{\mathrm{AT}}\}$

Given (31), it will be expected that $[\mathbf{N_{count}}]_{\mathbf{mass}}$ can denote N-atoms, N-fragments and their mixture. Thus, it has to be clarified what gives rise to the preference for N-fragments over N-atoms when $[\mathbf{N_{count}}]_{\mathbf{mass}}$ is being used, as this asymmetry is not literally encoded in definition (31). Considering that natural atomlessness cannot be part of the semantics of $[\mathbf{N_{count}}]_{\mathbf{mass}}$, it is most probable to find the origin of favoring N-fragments over N-atoms in pragmatics.

Recall that even the grammatically flexible noun **rock**, when occurring in its mass form without classifiers, cannot serve as a *perfect* description of a pile of rocks, despite the fact that (sums of) ROCK-atoms also fall under $\llbracket \mathbf{rock_{mass}} \rrbracket$. What may well be confusing is the perfect felicity of (28), given the fact that rocks (i.e., ROCK-atoms) also form part of the material of which the Earth's outer solid layer is made. This contrast of felicity naturally draws attention to the difference between the Earth's outer solid layer and the pile of rocks. Despite the fact that both contain rocks, the former is so great in size that it could be perceived as being a coherent body without salient atomic structure; whereas the pile of rocks, given the description in (27) **a pile of rocks**, is most likely to be imagined as a pile of rocks with readily visible individual components. Following the general semantics of the mass/count distinction introduced in Section 2, the interpretation of the two forms of **rock** could be formulated as (32).

(32)   a. $\llbracket \mathbf{rock_{mass}} \rrbracket = \mathrm{ROCK}_+$
        b. $\llbracket \mathbf{rock_{count}} \rrbracket = \{\langle d, c \rangle : d \in \mathrm{ROCK_{AT}}\}$
        c. $\llbracket \mathbf{rocks} \rrbracket = \{\bigsqcup S : \emptyset \subsetneq S \subseteq \llbracket \mathbf{rock_{count}} \rrbracket\}$

The elements of $\llbracket \mathbf{rocks} \rrbracket$ are pluralities consisting of count atoms that are grammatically accessible. In contrast, each element of $\llbracket \mathbf{rock_{mass}} \rrbracket$ is a mereological sum, in which no atomic elements are grammatically accessible. The inaccessibility of atoms is evidenced by the ungrammaticality of taking **rock_mass** as the antecedent of a reciprocal (33).

(33)   *(The) Rock is piled on top of each other.

Formally, the inaccessibility of atoms and thus the unity of a mereological sum are enforced by the fact that mereological part-of relation holds not only between an atom and a sum of atoms (e.g., between a chair and a sum of multiple chairs) but also between a fragment of an atom and the sum of atoms (e.g., between a chair leg and the sum of multiple chairs). In other words, the mereological

part-of relation cannot distinguish atoms from fragments of atoms if both are contained in a sum. As a consequence, the atoms constituting a sum are not 'visible' in the semantic representation. Therefore, each mereological sum is *formally* atomless.

Specifically, a pile of ROCK-atoms, as an element of ⟦**rock$_{mass}$**⟧, is represented as an atomless and thus coherent body, despite the existence of individual rocks. Still, the mere formal atomlessness inherent to a mereological sum cannot account for the imperfectness of (27), since aggregations of FURNITURE-atoms are also represented as sums in ⟦**furniture**⟧ but it is perfectly felicitous and grammatical to denote an aggregation of multiple pieces of furniture by **(the) furniture**.

A salient contrast between the two names, **rock$_{mass}$** and **furniture**, is that the former by default also has a count form **rock$_{count}$**, which refers to aggregations of ROCK-atoms as pluralities (32b, 32c) with individual rocks being grammatically accessible. Thus, the usage of **rock$_{mass}$** in (27) could trigger the implicature that what is denoted is perceived as an atomless and coherent body (as the mass form, rather than the alternative count form, is used), which is at odds with the salient atomic structure of the pile of rocks. Hence, it is not unexpected that (27) is not perfectly felicitous.

The same logic also applies to (25) and mass usage of predominantly count nouns in general. Given the existence of the default count form of **chair**, usage of the mass form **chair$_{mass}$** gives rise to the implicature that what is described (i.e., the chair tower) is perceived as and therefore referred to as an atomless and coherent body. However, the object is a tower composed of hundreds of chairs, which is far from being atomless. In contrast, an utterance of (19) is felicitous if what is on the floor is (completely) decomposed bicycles. That is, the BICYCLE-atoms are no longer perceivable, or at least, far from being salient.

Overall, grinding (i.e., natural atomlessness) is probably the most usual force driving the usage of the mass form of a predominantly count noun. Otherwise, the default count form would have been used. In other words, fragments of N-atoms, which cannot be counted as N-atoms and thus cannot be denoted by **N$_{count}$**, but which stand in a close relation to the later and fall under the denotation of [**N$_{count}$**]$_{mass}$, is the most likely trigger of the usage of [**N$_{count}$**]$_{mass}$.

Nonetheless, it is observed that the use of the mass forms of **banana** and other names of fruits and vegetables is less problematic even if what is described is an aggregation of atomic objects. The question could be formulated as: what makes people more willing to refer to a large aggregation of bananas as an atomless and coherent body? Given the definition (31) in terms of formal atomlessness, the answer could be obtained by examining the difference in the perception of the chair tower vs. the banana tower.

4.2. Homogeneity: From Referents to Expressions

As is argued in Section 4.1, the infelicity of (25) is resulted from the mismatch between (i) the formally atomless representation encoded in **chair$_{mass}$** and (ii) the salient atomic structure of the chair tower, given the availability of the alternative count form **chair$_{count}$**. That is, the chairs forming the tower are salient atomic components of the construction. This tension is also inevitable with respect to the banana tower exclusively composed of whole bananas (26), which nonetheless appears to be significantly more felicitous.

First, there is no motivation to assume a different semantics for **banana$_{mass}$** than (31) to undermine the tension. Thus, the contrast in felicity is most likely to be a consequence of the difference between the perception of the two objects. Specifically, it needs to be explained why it is less problematic to perceive and thus represent the banana tower as an atomless and coherent body. This issue could be alternatively formulated as: why each whole banana is less salient as an atom of the banana tower?

The absence of a significant contrast in acceptability between (26) and (27) provides a clue. Although both **chair** and **banana** are predominantly count nouns whereas **rock** is a flexible noun, the results regarding (25), (26) and (27) indicate that bananas are more similar to rocks than to chairs in some aspect that notably influences people's perception of aggregations. One prominent distinction between chairs and rocks is that chairs are *indivisible*, while rocks are not. Formally, I define indivisibility with respect to number-neutral property N: $d \in N_+$ is indivisible iff

(34) for any two non-overlapping entities a and b such that $a, b < d$, it holds that $a \in N_-$ or $b \in N_-$ (Cai 2015)

By this definition (34), a chair is indivisible because any way of dividing a chair will produce at least one proper part that is definitely not a chair. In contrast, rocks are generally *homogeneous* in the sense that a rock can be divided into multiple fragments all of which fall under ROCK$_+$, even if not all of them could be counted as *a rock*. Formally, $d \in N_{AT}$ is homogeneous iff

(35) there are two non-overlapping $a, b \in N_+$ such that $a \oplus b = d$

There are several points which are noteworthy and which in themselves should be discussed in detail if without limit of length. Firstly, ROCK$_{AT} \subsetneq$ ROCK$_+$ and the inequality between ROCK$_+$ and ROCK$_{AT}$ is justified by the fact that **rock$_{mass}$** denotes a mineral matter with variable composition and **a rock** denotes a piece of such mineral matter which is subject to (vague) constraints on shape and size. Secondly, definition (35) cannot serve as a criterion for homogeneity in general, as sums of atomic objects also satisfy this description. For instance, the sum of multiple chairs

could be divided into two sub-aggregations both of which are contained in CHAIR$_+$. Rather, definition (35) characterizes the homogeneity of entities with atomic structures in terms of divisibility of atoms. Recall that the notion of homogeneity defined in (35) comes with the constraint that $d \in N_{\text{AT}}$. Although this definition may not be as general as expected, it succeeds in characterizing the homogeneous atomic objects denoted by flexible nouns in contrast with the indivisibility of atoms denoted by predominantly count nouns such as **chair** and **bicycle**. Furthermore, homogeneity does not mean infinite divisibility. As has been widely noted, if a rock is repeatedly divided, there will come a point where the remainder is no longer an element of ROCK$_+$.

As for names of fruits and vegetables, it might be expected that they are on a par with other predominantly count nouns such as **chair** regarding indivisibility. However, many informants think (36) is an appropriate (though probably imperfect) description of a box containing only halves of bananas each of which is obtained from a different banana.

(36)   There are bananas in the box.

However, a half of a banana is *not definitely* a banana. If people are asked to pick out a banana from a box containing a whole banana and a half, the whole banana will be most likely to be selected. Hence, half a banana is most likely to fall under the vagueness band BANANA$_?$ rather than the positive extension BANANA$_+$. As a consequence, bananas are neither indivisible nor strictly homogeneous. In other words, they appear to be *weakly homogeneous*. Intuitively, at least two aspects underlie the contrast between bananas and chairs. *Structurally*, cars and bicycles have fine-grained and salient inner structures, whereas a banana can be roughly perceived as a coherent body made of 'banana stuff' without salient inner structures. *Functionally*, a car cannot be divided into multiple parts all of which can function as cars, while half a banana is also edible and provides the same nutrients as do whole bananas.

Given the weak homogeneity of BANANA-atoms, each of them could be approximately perceived as a portion of banana stuff. Therefore, the banana tower could be roughly perceived as a large portion of banana stuff and its representation could (imperfectly) be formally atomless, which is encoded in **banana$_{\text{mass}}$**. That is, the (weak) homogeneity significantly undermines the tension between the natural atomicity of bananas and the formally atomless representation (31) of the aggregation of bananas.

Nonetheless, the homogeneity formulated as (35) does not guarantee grammaticality and felicity of using mass forms of predominantly count noun phrases. For instance, a bar of chocolate could be divided into two fragments both of which also fall under the denotation of **bar of chocolate**, whereas (37) is still ill-formed.[4]

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[4]Thanks to a reviewer for drawing my attention to such examples.

(37)   *The tower is made of bar of chocolate.

An account analogous to that of the ungrammaticality of mass forms of group nouns applies to (37). The classifier **bar** serves as an atom generator that extracts atomic entities out of the denotation of **chocolate$_{mass}$**. The application of this classifier indicates that the chocolate is being referred to as an atomic entity. However, the mass form of **bar of chocolate** refers to the chocolate as being formally atomless. Therefore, two incompatible operations are applied to **chocolate$_{mass}$**, which leads to the ill-formedness of (37).

To sum up, it is formal atomlessness (rather than natural atomlessness) that is encoded in the mass forms of predominantly count nouns. Given the availability of the default count form, usage of the mass form implicates that the referent is perceived as atomless, which in turn triggers the implicature that the referent does not include atoms (i.e., naturally atomless). However, the second step of implicating is weakened when the atomic elements comprising the referent are (weakly) homogeneous. That is, the (weak) homogeneity of atomic components enables people to perceive the aggregation as a coherent body. As a consequence, the grinding implicature is significantly undermined, as is illustrated by (26).

Such a grinding implicature is also available to grammatically flexible nouns such as **rock**, which is instantiated by the imperfectness of (27). However, there is still a distinction between flexible nouns and predominantly count nouns. The former have both a count form and a mass form by default, whereas the mass form of the latter is *marked*. For instance, sentence (28) is felicitous despite the fact that the outer solid layer of the Earth contains numerous pieces of rock that could be counted as *rocks* (i.e., ROCK-atoms). This phenomenon is actually in line with the analysis based on formal atomlessness. The rocks, when being viewed as part of the outer solid layer of the Earth, are so tiny that the whole outer solid layer could be perceived as an atomless and coherent body and be denoted by **rock$_{mass}$**. In contrast, the mass form of a predominantly count noun is *marked*. As a consequence, usage of $[\mathbf{N_{count}}]_{\mathbf{mass}}$ will not be perfectly felicitous as long as the predominant count form $\mathbf{N_{count}}$ is applicable. Therefore, even if the surface of the Earth is entirely covered with bananas, an utterance of (38a) is not perfect, while (38b) is still a better way to describe the Earth.

(38)   a.   The Earth is covered with banana.
        b.   The Earth is covered with bananas.

Hence, the usage of $[\mathbf{N_{count}}]_{\mathbf{mass}}$ is most felicitous when the referent can no longer be denoted by $\mathbf{N_{count}}$. Such a situation occurs when the atomic structure of the referent is lost, for example, when the atomic objects are ground. Nevertheless, this does not justify the proposal of encoding natural atomlessness into the semantics of $[\mathbf{N_{count}}]_{\mathbf{mass}}$, since N-atoms are not strictly excluded from $[\mathbf{N_{count}}]_{\mathbf{mass}}$, as is illustrated by the significant contrast between (25) and (26). Rather, grinding (i.e.,

natural atomlessness) is an implicature triggered by the formally atomless representation (31) and the availability of the unmarked count form N_{count}.

Moreover, such an analysis is in accordance with the general observation that the mass/count distinction concerns the way nominals refer, rather than the structures of the things they refer to.

5. Conclusion

The contrast between mereological sum and plurality underlies a variety of semantic properties of nominals, including those concerning the mass/count distinction. The inherent unity and formal atomlessness that come with mereological sum account for the tendency of mass forms of predominantly count nouns to denote fragments of atomic objects. The universal grinder appears to capture such tendency, but it oversimplifies the image of massification of count nouns and thus fails to account for the variation illustrated by (25) and (26). Instead, it is formal atomlessness that triggers the implicature of natural atomlessness, which is sensitive to the indivisibility and homogeneity of referents. In order to thoroughly examine this analysis, more types of nominals need to be tested apart from names of artifacts, fruits and vegetables.

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Asserting Clarity & Managing Awareness[1]

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Abstract. Barker and Taranto (2003) introduce the "paradox of asserting clarity," arguing that true assertions of the form *It is clear that p* are necessarily uninformative. Following a Stalnakerian perspective according to which assertions are felicitous only if they are informative, assertions of clarity should therefore never be felicitous: either they are false or they are uninformative. I address this problem in two ways. First, I argue for a semantics of *clear* according to which assertions of clarity may be both true and straightforwardly informative in certain contexts. Second, I argue that in those contexts in which asserting the clarity of p appears to be uninformative, such an assertion may nonetheless by felicitous in virtue of its function of raising awareness of p. I formalize this proposal using a model of awareness in discourse following Franke and Jager (2011).

Keywords: assertions of clarity, awareness, uninformativity

1. Introduction

Barker and Taranto (2003) argue that true assertions of clarity are necessarily uninformative. To illustrate, suppose there is a picture in front of us labelled "Mindy" that shows a woman wearing a white coat and a stethoscope. In such a context, (1) may be felicitously asserted.

(1) It is clear that Mindy is a doctor.

The felicity of (1) depends upon the existence of evidence that Mindy is a doctor. In this case, the evidence is Mindy's attire. If the photograph instead showed a woman dressed in plain clothes, (1) would not be felicitous. In addition, it appears that this evidence must be publicly available. Suppose again that the photograph showed Mindy dressed in plain clothes, but that I also possessed private evidence that Mindy was a doctor. Still, (1) would not be felicitous. From these observations, we can offer a first-pass, informal proposal for the truth conditions of clarity statements. A proposition of the form *It is clear that p* is true if and only if there exists publicly available evidence, i.e. evidence that is available to all discourse participants, supporting the conclusion that p (the "prejacent").

Now suppose a speaker truly asserts the clarity of some proposition p. It follows that there is evidence supporting p available to all discourse participants. Assuming these discourse participants to be rational, they should all recognize the existence of the publicly available evidence that supports

p. As a consequence, all discourse participants should already know that p is clear and should have already concluded p. Thus, any assertion of the clarity of p should be uninformative. What, then, is the purpose of asserting clarity?

Resolving this question is the central concern of this paper, which is organized as follows. In §2, I offer a more detailed semantics for propositions of the form *It is clear that p*. It follows from this proposal that there are true, straightforwardly informative assertions of clarity. Still, in many contexts, clarity assertions are not obviously informative, and I discuss previous proposals for handling these cases in §4. I ultimately reject these existing accounts, and in §5 I offer a novel proposal for seemingly uninformative clarity assertions that is based on the potential of such assertions to raise awareness of discourse participants.

2. The Semantics of *Clear* & Informative Clarity Assertions

The existing literature on assertions of clarity (Barker and Taranto, 2003; Bronnikov, 2008; Barker, 2009; Wolf and Cohen, 2011; Barker, 2011; Wolf, 2014) observes that clarity statements may be relativized to a particular individual or group, as shown in (2).

(2)   It is clear to me/you/Donald Trump that Mindy is a doctor.

Such expressions are typically referred to as statements of "personal clarity," in contrast to statements of "simple clarity," such as that in (1). Clarity statements may also make explicit the evidence from which the prejacent follows (Barker, 2009; Bronnikov, 2008).

(3)   It is clear from what she is wearing/from the diplomas in her office/from her extensive knowledge of anatomy that Mindy is a doctor.

There is no term generally used to refer to clarity expressions such as (3). Here, I refer to them as statements of "evidential clarity."

In order to have a unified explanation of simple, personal, and evidential clarity expressions, I assume that *clear* takes three arguments: a prejacent, an experiencer, and a body of evidence. While the prejacent must be stated explicitly, the experiencer and evidence arguments may be left implicit. We can account for the truth conditional meaning of each type of clarity statement by first giving an account of the truth conditions in cases in which all arguments are stated explicitly and then giving accounts for the interpretation of experiencer and evidence arguments when they are implicit.

To begin, consider the following clarity statement in which each argument of *clear* is explicit:

(4)   It is clear to me from what she is wearing that Mindy is a doctor.

Intuitively, (4) entails that the speaker believes the prejacent and that the evidence plays some causal role in the speaker possessing this belief.[2] These intuitions appear to be confirmed by the infelicity of (5a) and (5b).

(5)   a. # It is clear to me from what she is wearing that Mindy is a doctor, but I don't believe she is a doctor.
       b. # It is clear to me from the fact that 2 + 2 = 4 that Mindy is a doctor.

On this view, (5a) is infelicitous because the second conjunct of contradicts the first. Example (5b) is infelicitous because, whether or not it is actually clear to the speaker that Mindy is a doctor, it is hard to imagine how the fact that $2 + 2 = 4$ could play a causal role in the speaker's beliefs about this matter.

These intuitions will help us accurately characterize the meaning of clarity propositions. One final aspect of *clear* that must be reflected in its truth conditions is the fact that *clear* is a gradable predicate, as shown by the grammaticality of expressions such as *very clear* and *reasonably clear*. Following Barker (2009), I further assume that *clear* is a vague predicate. I do not offer evidence for this position here, but see Barker (2009) for a Sorites paradox involving clarity.[3]

These observations allow us to informally characterize the meaning of clarity statements as follows: *It is clear to x from e that p* is true if and only if x possesses the evidence e and e is sufficient evidence for x's degree of belief in p to be at least as great as some contextually relevant degree d. In §5, I introduce a model of agents' doxastic states which can be used to formalize this proposal for the meaning of *clear*.

While the prejacent must be explicit in all clarity expressions, we observed above that either the experiencer or the evidence may be left implicit. Following Condoravdi and Gawron (1996), implicit arguments can receive either an existential interpretation or an anaphoric, context-dependent interpretation. This contrast is illustrated by (6):

(6)   a. There was a piece of bread on the table, but John didn't eat.
       b. There was a good job available, but Fred didn't apply.

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[2]This conclusion is shared by Barker and Taranto (2003); Bronnikov (2008) and Wolf and Cohen (2011), but see Barker (2009) for an alternative perspective.

[3]Interestingly, *clear* appears to be one of the few predicates that is vague, but allows modification with maximality modifiers like *100%* and *completely*. Another such predicate is *bald* (Kennedy, 2007).

In (6a), *eat* has an implicit argument that receives a narrow scope existential interpretation; (6a) is true only so long as John ate nothing. In particular, if John did not eat the piece of bread on the table but did eat something else, (6a) is false. In contrast, the implicit argument of *apply* in (6b) receives an anaphoric interpretation. We understand this sentence to mean that Fred didn't apply for the good job that was available, but it is possible that Fred applied for something else, such as a loan.

Let's now consider how to classify implicit arguments of *clear* using this typology. First, consider cases of personal clarity in which the evidence argument is left implicit, such as (7).

(7)   Mindy is wearing a white coat and a stethoscope, but it is not clear to me that she is a doctor.

If the implicit evidence argument of (7) were interpreted anaphorically, we would expect (7) to be true so long as Mindy's attire does not play a causal role in the speaker believing that Mindy is a doctor. Crucially, such an interpretation would leave open the possibility that it is clear to the speaker that Mindy is a doctor, but that the speaker's belief that Mindy is a doctor is based on some other body of evidence. However, this is not the interpretation that (7) receives. Rather, it follows from (7) that there is no evidence whatsoever that leads the speaker to the conclusion that Mindy is a doctor. Thus, the implicit evidence argument receives an existential interpretation.

In contrast, an implicit experiencer argument appears to receive an anaphoric interpretation based on context.[4] Consider (8):

(8)   The board of directors met last night. It was not clear that the CEO had to be replaced.

The most natural interpretation of (8) is one in which it is not clear to the board of directors that the CEO had to be replaced. Of course, this is compatible with it being clear to someone else, such a disgruntled investor, that the CEO had to go.

These considerations allow us to challenge the arguments supporting the paradox of asserting clarity discussed in the previous section. First, note that the paradox of asserting clarity only arises in the context of simple clarity assertions. In particular, assertions of personal clarity do not generally give rise to the paradox. Personal clarity only requires that the experiencer possess the relevant evidence supporting the prejacent and that the experiencer believe the prejacent. Personal clarity says nothing about whether agents excluded from this experiencer argument either possess the relevant evidence or believe the prejacent. Thus, if some discourse participants are excluded from this expe-

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[4]This proposal regarding the implicit experiencer argument of *clear* closely resembles various contextualist approaches to epistemic modality (Kratzer, 1981; DeRose, 1991; von Fintel and Gillies, 2008; von Fintel and Gillies, 2011; Stalnaker, 2014).

riencer, there is no reason to think that they possess the relevant evidence or that they would have concluded the prejacent. It follows that assertions of personal clarity may be straightforwardly informative.

Next, we simply recognize that this argument applies whether or not the experiencer is stated explicitly. If simple clarity is asserted and the implicit experiencer argument receives an interpretation that excludes some discourse participants, then the assertion may be informative. It is common to encounter such uses of *clear* in journalistic contexts. For example, consider the following from the Corpus of Contemporary American English (COCA; Davies 2008):

(9) a. It is clear that Maliki has come out as the winner in the political crisis he provoked. He has made it more difficult for his Shia rivals to dissent while simultaneously confining his Sunni opponents in a position suitable for exerting pressure and exploiting divisions within their ranks.

b. But look closer at the China model, and it is clear that it is not so easily replicated. Most developing countries do not have China's bureaucratic depth and tradition, nor do they have the ability to mobilize resources and control personnel in the way that China's party structure allows.

The implicit experiencer argument in both examples in (9) is, intuitively, experts or those "in the know." This experiencer will often exclude the addressee, who is presumably not an expert and is interested in learning about Iraqi politics or the Chinese economic model. Thus, we expect these clarity assertions to be straightforwardly informative. The fact that the evidence supporting the prejacent is provided after clarity is asserted further supports the claim that these simple clarity assertions are intended to be informative. If the addressee already possessed evidence supporting the prejacent, then explicitly stating this evidence would be superfluous.

If clarity assertions can be straightforwardly informative in this way, what is the appeal of the argument presented in §1? Most previous researchers have assumed, contra the claims here, that implicit experiencer arguments must include all discourse participants.[5] If this assumption were true, then the paradox would, indeed, reemerge for all cases of simple clarity. But even on the more nuanced picture presented here, we can imagine that in many cases, the implicit experiencer argument of *clear* does include all discourse participants. For example, this is the most plausible understanding of the implicit experiencer in (1). In such cases, we must find some other explanation for the function of clarity assertions. In the next section, I consider several previous analyses of the function of clarity assertions when the experiencer argument includes all discourse participants.

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[5]Barker (2009) acknowledges that implicit experiencer arguments may take other values, but the default is for this argument to include all discourse participants.

3. Previous Proposals for Uninformative Clarity Assertions

3.1. Barker (2009)

Barker (2009) leverages the vagueness of *clear* to argue that the effect of asserting clarity is not to inform discourse participants about the prejacent or about any agent's beliefs in the prejacent. Rather, the function of assertions of clarity is to establish a minimum standard for what counts as clear in the given context. Barker proposes a slightly different semantics for *clear* than that given in §2. Inspired by Kratzerian approaches to modality (Kratzer, 1981), Barker assumes the presence of a stereotypical ordering source $g(w)$ in the common ground, which induces an ordering on worlds $\leq_{g(w)}$ ind. Next, Barker assumes the existence of a measure function $\mu(w)$ mapping worlds to degrees such that $\mu(w) \leq \mu(w')$ if and only if $w \leq_{g(w)} w'$. Finally, if d is a contextually relevant standard for clarity, a proposition p is clear if and only if for all worlds w such that $\mu(w) \leq d$, $w \in p$. That is, p is clear if and only if all of the most "normal" worlds are p-worlds.

Since $g(w)$ is in the common ground, there can be no doubt among discourse participants regarding any proposition's degree of normality. However, there can be doubt about whether a world's degree of normality meets the contextual standard for clarity in the context. The effect of asserting clarity is to set a minimum value for this standard. For example, asserting (1) has the effect of establishing that however clear it is that Mindy is a doctor, that will count as clear in the present context. Similar effects can be observed in the use of other vague adjectives. Barker gives the following example:

(10) a. A: I'm new in town. What counts as tall around here?
      b. B: See Bill over there? Bill is tall.

B's assertion in (10b) does not inform A about Bill's height, since both A and B can see how tall Bill is. Rather, (10b) informs A of the contextual standard for tallness. On Barker's proposal, this is the only type of function that asserting clarity can have.

Several authors have leveled criticisms against Barker's proposal, three of which I consider here. First, Wolf and Cohen (2011) point out that on Barker's account, it should be impossible to have disagreements regarding simple clarity assertions. Consider our original example with Mindy wearing a white coat and a stethoscope, but further assume that she is shown holding a lit cigarette. We could imagine the following exchange:

(11) a. A: It is clear that Mindy is a doctor (because she's wearing a white coat and a stethoscope).
      b. B: No, it is clear that Mindy is not a doctor (because she's smoking).

On Barker's account, all discourse participants share the ordering source $g(w)$, and therefore share

judgments about the relative clarity of two propositions. This predicts that we should never encounter a situation like that shown in (11), but such cases are unremarkable. Barker (2011) responds to this criticism by allowing that discourse participants may be in disagreement about the correct ordering source $g(w)$. While this successfully addresses Wolf and Cohen's concern, it is a relatively large departure from Barker's earlier claim in Barker (2009). Moreover, even with this adjustment, Barker's proposal faces two additional problems.

Bronnikov (2008) highlights two problematic cases for Barker's proposal. First, Bronnikov considers repeated clarity assertions that depend upon similar bodies of evidence. Suppose a woman wearing a white coat and a stethoscope walks by A and B. A may felicitously assert (12a). Next, a man walks by dressed the same way. It is then felicitous for B to assert (12b).

(12)   a. A: It is clear that she is a doctor.
        b. B: It is clear that he is a doctor, too.

On Barker's account, the assertion of (12a) sets a contextual standard for clarity such that it is clear that a person wearing a white coat and a stethoscope is a doctor. But then (12b) should follow immediately from the fact that the man is wearing a white coat and a stethoscope. B's assertion in (12b) can have no effect on our understanding of either the contextual standard for clarity or the appropriate stereotypical ordering source. Nonetheless, (12b) is felicitous.

Bronnikov also points out that Barker's proposal predicts the assertion of the clarity of a necessarily true proposition to have no contextual effects. Consider (13).

(13)   Take an integer n that is divisible by 9. It is clear that n is divisible by 3.

Since a number that is divisible by 9 will be divisible by 3 in all possible worlds, any choice of ordering source and any contextual standard of clarity will make the clarity statement in (13) true. Once again, Barker's account predicts this clarity assertion to serve no purpose.

3.2. Wolf and Cohen (2011)

As discussed above, Wolf and Cohen (2011) argue against Barker's proposal for the function of clarity assertions. On Wolf and Cohen's alternative analysis, the meaning of personal clarity statements is largely similar to the proposal in §2. However, in the case of simple clarity, Wolf and Cohen do not take the implicit experiencer argument to be evaluated in an anaphoric, context-dependent manner. Rather, they take simple clarity to embody an "objectivized" form of belief. This is obtained by taking the weighted average of all reasoners' degrees of belief in the prejacent, where each reasoner is weighted by how good a reasoner they are. A proposition is clear if this

weighted average exceeds the contextual threshold for clarity. Informally, Wolf and Cohen propose that a proposition is clear if and only if it is believed by good reasoners.

Wolf and Cohen's account is perhaps most plausible for cases such as (9), in which simple clarity assertions do appear to depend upon the beliefs of experts or good reasoners. This proposal also succeeds in avoiding the problem illustrated by (11), since two interlocutors may disagree about what is believed by good reasoners. But Wolf and Cohen's proposal still faces a difficulty in explaining repeated assertions of clarity based on similar bodies of evidence. On Wolf and Cohen's account, after a speaker has asserted (12a), it follows that good reasoners' degree of belief that a woman dressed in a white coat and stethoscope is a doctor exceeds some threshold d. It does not follow as a logical consequence that good reasoners would also assign a high degree of belief to the proposition that a man dressed in the same way is a doctor. Nonetheless, we would have to have relatively odd views about good reasoners for (12b) to fail to be true. In other words, making relatively weak assumptions about the beliefs of good reasoners, Wolf and Cohen's account predicts that (12b) should serve no function after the assertion of (12a).

Turning to the assertion of the clarity of necessarily true propositions (13), Wolf and Cohen have no problem in guaranteeing that such propositions are true. We would certainly expect good reasoners to assign high degrees of belief to necessarily true propositions. But it is unexplained why exactly we should care what good reasoners believe regarding necessarily true propositions, since presumably the discourse participants themselves are capable of concluding that such propositions are true. This critique highlights a more general problem for Wolf and Cohen's approach that extends to cases in which the prejacent is not necessarily true. In particular, when a proposition could easily be inferred by all discourse participants, why should it matter what "good reasoners" would conclude? Why should we care, for example, that good reasoners can conclude that Mindy is a doctor in (1) when the discourse participants themselves are capable of reaching such conclusions?

3.3. Bronnikov (2008)

Bronnikov (2008) develops a "missing inference" analysis of clarity assertions. The intuition behind this approach is that although the contextually available evidence supports p, not all discourse participants may have actually inferred p from this evidence. The point of asserting clarity is to point out to other discourse participants the availability of a particular inference that they may not yet have computed. In Bronnikov's words, after a speaker asserts clarity, each discourse participant is "invited to build the inference for himself" (149).

Bronnikov takes an expression of the form *It is clear to x that p* to be true if and only if x has performed a sound inference whose conclusion is p. Formally, we write $\mathbf{B}_\alpha p$ to mean that agent α believes p. Bronnikov does not assume that beliefs are closed under entailment or any notion of rational inference. Rather, agents' belief states are expanded through the application of inference

rules. Therefore, agents may believe in the existence of evidence that supports p, but may fail to actually believe p in virtue of having not employed the necessary inference rules. These inference rules are divided into the sets $Triv_\alpha$, $Easy_\alpha$, and $Hard_\alpha$, representing trivial, easy, and hard inferences for an agent α, respectively. We write $\langle A \rangle p$ to mean that p holds after the application of some subset of the rules in A. Using this formalism, *It is clear to x that p* is true if and only if $\langle Easy_x \rangle \mathbf{B}_x p$ and presupposes that $\neg \langle Triv_x \rangle \mathbf{B}_x p$. This presupposition is included in order to rule out expressions such as the following:

(14)   a. John ate a sandwich and a bag of chips.

          b. ?? Therefore, it is clear that John ate a sandwich.

Bronnikov's approach avoids several of the shortcomings of the proposals considered above. With respect to disagreements, there is nothing preventing two agents from inferring contradictory conclusions, even if they share the same evidence. With respect to repeated assertions of clarity based on similar bodies of evidence, reaching the conclusion in each case requires a separate inferential process that may or may not occur. Therefore, each assertion can play the role of highlighting a separate inference available to the discourse participants. With respect to the clarity of necessarily true propositions, agents may fail to believe propositions that are necessarily true since their beliefs are not closed under entailment. Beliefs in necessarily true propositions must still be formed via some inferential process, and asserting the clarity of these propositions can draw attention to these inferences.

Despite these successes of Bronnikov's proposal, it still suffers from a number of problems. First, there is an inconsistency regarding the interpretation of $\langle A \rangle p$. Bronnikov's prose suggests that this formula should be interpreted as meaning that p now holds as a result of the application of some subset of the actions in A. But if this is the case, then there seems to be no way to correctly account for cases of simple clarity in which the experiencer includes all discourse participants. On such an interpretation of the experiencer argument, *It is clear that p* would have to mean that all discourse participants have performed easy inferences and have concluded p. But now we face the paradox of asserting clarity again: all discourse participants have already concluded p, so what is the point of asserting that it is clear?

We might instead interpret $\langle A \rangle p$ as a type of conditional: p would hold *if* some subset of A were applied. In this case, we avoid the problem of recreating the paradox of asserting clarity. Even if all discourse participants would believe p if they were to apply some subset of the actions in A, this does not mean that these agents actually have applied these actions. But we now have a problem with the presupposition of *clear*. If we interpret $\langle A \rangle p$ as meaning that p would hold if some subset of A were applied, the presupposition of *clear* is that it is not the case that x would believe p if x were to perform some set of trivial inferences. Since a speaker who asserts the clarity of p presumably already believes p, there exists a trivial inference available to this speaker that has p as its premise and p as its conclusion. Whether or not the speaker actually performs such a trivial

inference, the presupposition of *clear* should always be unsatisfied simply because this inference is available. Thus, there seems to be no consistent way to interpret $\langle A \rangle p$.

It is also questionable whether we want to classify the oddness of (14b) as being the result of a presupposition failure. If this were the case, we would expect this "presupposition" to project in contexts such as questions, the antecedents of conditionals, and in the scope of negation. But the negation of (14b) in a context immediately following the assertion of (14a) appears to be false, rather than undefined:

(15)   a. John ate a sandwich and a bag of chips.
       b. # Therefore, it is not clear that John ate a sandwich.

A final problem for Bronnikov's analysis comes from examples of clarity assertions in which it is not obvious that any inference is involved or, if an inference is involved, it is a very trivial one. For example, suppose I am packing for a business trip to LA in the dead of winter. While I am busy packing my heavy winter coats, a friends asks me the following:

(16)   Why are you packing all of that? It's clear that it might be warmer in LA.

Intuitively, my friend's utterance simply reminds me of a possibility that I have forgotten. It is not obvious that I must now perform an inference whose conclusion is that it might be warmer in LA. A defender of Bronnikov's account would face the burden of explaining why an inference with such a weak conclusion is non-trivial.

In spite of these issues, I take the core insight of Bronnikov's analysis to be correct. When clarity assertions appear to be uninformative, they do seem to play a role in highlighting a conclusion that a discourse participant has failed to recognize. In the next section, I offer an alternative account of how to cash out this intuition.

4. Clarity Assertions and Awareness

The central idea behind the present proposal is that although there may exist publicly available evidence supporting some conclusion that p, discourse participants may be unaware of this evidence or of the conclusions that follow from this evidence due to inattentiveness or forgetfulness. When this is the case, a speaker may assert the clarity of p to draw their interlocutors' attention to either the evidence supporting p or to p itself. Raising awareness in this way may then serve the goals of the interlocutors in further reasoning or in solving some decision problem they face.

These ideas are formalized using a simplified version of the model of awareness dynamics pre-

sented in Franke and Jager (2011).[6] We begin by defining for each agent α a background probability distribution over propositions $P_\alpha : \wp(\mathcal{W}) \to [0, 1]$. Each agent is also associated with a set of "unmentionable" propositions $\mathfrak{U}_\alpha \subseteq \wp(\mathcal{W})$ and assumptions $\mathfrak{A}_\alpha \subseteq \mathfrak{U}_\alpha$ for α. Finally, we define α's filtered probability distribution given $\mathfrak{A}_\alpha$ as $P'_\alpha = P(\cdot \mid \cap \mathfrak{A})$.

Unmentionable propositions represent are those propositions that fail to distinguish possible worlds for an agent. Alternatively, we may think of unmentionable propositions as those which an agent fails to have explicit beliefs about. The basic idea has a long history in the linguistic and philosophical literature (Lewis, 1979; J. Groenendijk and Stokhof, 1984), and similar ideas have recently been used to explain phenomena regarding epistemic modality (von Fintel and Gillies, 2010; Yalcin, 2011). To illustrate with an example from Yalcin (2011), suppose an agent is not considering whether it is raining in Topeka now. The proposition that it is raining in Topeka now may nonetheless be compatible with the agent's beliefs. We may say that, given the agent's beliefs, it might be raining in Topeka. But at the same time, we it would be incorrect to say that the agent *explicitly* believes that it might be raining in Topeka, since the agent is not considering the issue. Rather, this is an implicit belief, which could become explicit if the agent were to consider it consciously. On Franke and de Jager's model, if p were the proposition that it is raining in Topeka now and α were an agent who is not aware of p, we would have $p \in \mathfrak{U}_\alpha$.

One of the key contributions of Franke and de Jager's model is to recognize that the type of implicit belief described above is not the only form that unawareness may take. To illustrate this second form of unawareness, suppose I have lost my keys and begin searching for them throughout my house. After a long search, I come up empty-handed. Finally, a friend of mine suggests that I check for the keys in my car. I smack my forehead and run out to look for my keys there. In this situation, I was originally unaware of the possibility that my keys were in the car. But, more than that, I behaved as if I knew that my keys were not in my car. On Franke and de Jager's model, we would say that I had an implicit assumption that my keys were in the house. Formally, if q were the proposition that the keys are not in the car and β were an agent who assumes that the keys are not in the car, we would have $q \in \mathfrak{U}_\beta$ and $q \in \mathfrak{A}_\beta$.

Both the background probability distribution P_α and the filtered probability distribution P'_α represent α's beliefs in some sense. The difference is that the background distribution represents these beliefs under full awareness, i.e. when α's sets of unmentionable propositions and assumptions are empty. In contrast, the filtered distribution represents an agent's beliefs conditioned on their implicit assumptions. As shown in the example involving the search for my keys, agents solve decision problems based on their beliefs under unawareness, i.e. according to their filtered probability distribution. For this reason, unawareness, particularly unawareness accompanied by assumptions, can cause agents to deviate from rational behavior. The above example also illustrates that unawareness can be easily overturned. If we have $p \in \mathfrak{U}_\alpha$ and an agent β mentions p,

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[6]Most notably, many of the decision theoretic aspects of Franke and de Jager's model are excluded here, although similar are discussed informally.

$\mathfrak{U}_\alpha$ is updated such that p is removed from it. In this way, agents can influence others' resolution to decision problems simply by making them aware of propositions, rather than informing them.

Now that we have a set of tools for modelling agent's doxastic states with unawareness, we can use these tools to formalize the proposal for the semantics of *clear* given in §2. Recall that we said that *It is clear to x from e that p* is true if and only if x possesses the evidence e and e is sufficient evidence for x to believe p to at least some contextually relevant degree d. One question that emerges given Franke and de Jager's awareness model is whether the relevant notion of belief for clarity statements is an agent's belief in the prejacent according to their background model or according to their filtered model. To resolve this issue, consider once again the example in which I have lost my keys. On my background probability distribution, I may very well have considered it quite likely that my keys were in my car. But given my unawareness of this possibility, it was impossible that my keys were in my car according to my filtered probability distribution. In this situation, it would be odd to say that it was clear to me that my keys were in the car while I was still unaware of this possibility. Thus, I take it that an agent's filtered probability distribution is relevant for clarity statements. A second issue that emerges is how to capture the notion that e is sufficient for some agent x to believe p. I formalize this by considering an agent x's beliefs given their body of evidence in a particular context, E_x, and comparing this to what their beliefs would be given this evidence, but with e removed. Putting these ideas together, let X be a set of agents, E_x be agent x's total body of evidence in some context c, and d be the standard for clarity in c. Then *It is clear to x from e that p* is true if and only if $\forall x \in X(P_x(p|E_x) > d \land P_x(p|E_x \setminus e) \not> d)$.[7]

Let's now illustrate how this proposal handles assertions of clarity that are seemingly uninformative. To make the effects of raising awareness on agents' behavior more salient, we will consider a context in which there is a clear decision problem facing the interlocutors. Suppose a friend and I go out looking for pastries in San Francisco. We come across two bakeries, Tartine and Arizmendi. There is a long line outside Tartine, while no such line is visible outside Arizmendi. My friend might turn to me and felicitously utter the following:

(17)   It is clear there is a wait at Tartine.

On the awareness model, we can straightforwardly understand the function of this assertion. On the one hand, I may have recognized the line outside Tartine but for some reason might fail to realize that this means there will be a wait at Tartine. On Franke and de Jager's model, we may say that I make an implicit assumption that there is no wait at Tartine. In this case, (17) would raise

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[7]This definition for clarity statements predicts that a proposition p may be clear to agent even if that agent is unaware of p, so long as the agent makes no assumptions about p. This seems correct. Even if I am not explicitly considering the fact that $2 + 2 = 4$, this does not mean that the proposition is not clear to me. The definition also rules out p being clear to an agent when the agent assumes p is true. Given such an assumption, there is no evidence e such that if e were removed from the agent's total body of evidence, the agent's subjective probability in p would fall below d. This also seems correct. If I assume that my keys are in the house due to unawareness of other possibilities, it does not seem appropriate to say that it is clear to me that my keys are in the house.

awareness of the proposition that there is a wait at Tartine, overturning my assumption. On the other hand, I may have failed to recognize the evidence in the context due to an implicit assumption that there is, in fact, no line outside Tartine. In this case, even if I made no assumption about there being a wait at Tartine, my filtered probability distribution might assign a low probability to there being a wait at Tartine due to my assumption about the lack of a line outside Tartine. Upon hearing (17), I can conclude that my friend possesses evidence that there is a wait at Tartine. This could be privately held evidence, similar to the examples in (9). But if I believed it to be unlikely that my friend possessed such private evidence, I could conclude that the utterance (17) was based on publicly available evidence. As a result, I would reexamine the context, recognize the line outside Tartine, and update my beliefs accordingly. In either case, the function of (17) on my behavior would be the same. It would be better for the two of us to get pastries without waiting for them. But if I do not recognize the wait at Tartine due to unawareness, I might try to go there anyway. By ensuring that I am aware of this proposition, my friend increases the chances that I reach an optimal solution to this decision problem.

Of course, if my filtered probability distribution does not encode the fact that there is a wait at Tartine and we adopt the proposal for the semantics of *clear* given above, it is not clear *to me* that there is a wait at Tartine. And therefore, it is, strictly speaking, false that it is clear to both me and my interlocutor that there is a wait at Tartine. In this way, it may appear that the paradox of asserting clarity has not been solved since we cannot interpret the implicit experiencer argument of *clear* in (17) as including all discourse participants and still have it come out as true.

We can counter this criticism by noting that if the implicit experiencer argument is interpreted as including all discourse participants, (17) is not true before it is uttered, but is true immediately after it is uttered. Due to the awareness-raising effects of this utterance, my assumptions, either about the wait itself or about the line outside Tartine, are immediately overturned. As a result, my filtered probability distribution will now encode belief that there is a wait at Tartine. Biting the bullet, we may say that my friend asserts something false in (17). However, the falsity of this utterance does not give rise to any infelicity due to the content of the utterance becoming true immediately afterwards.

Alternatively, we might adopt a proposal along the lines of that presented in von Fintel and Gillies (2011) for *might*. Adapting this proposal for *clear*, we would say that a speaker is licensed to assert simple clarity so long as they might outright assert personal clarity for some reasonable resolution of the implicit experiencer argument. In the case of (17), my friend is licensed to assert that it is clear that there is a wait at Tartine simpliciter because they may outright assert that it is clear to them that there is a wait at Tartine. However, in interpreting this utterance, a listener will attempt to resolve the implicit experiencer argument in the most informative way possible. In the case of (17), I interpret the implicit argument as including both myself and my friend. At the time I do so, the proposition that includes all discourse participants in its experiencer argument is true because I have been made aware of the prejacent and my beliefs have been updated accordingly.

Note that on this model, if I have recognized the line outside Tartine, am unaware of the proposition that there is a wait at Tartine, but make no assumption about this proposition, hearing (17) should not change my behavior. So long as I make no assumptions regarding either the evidence or the prejacent, my filtered probability distribution will encode the fact that there is a wait at Tartine. Although somewhat counterintuitive, this is not an outlandish conclusion. In such a situation, I could not utter anything regarding there being a wait at Tartine, but I could utter the following:

(18)   Let's not go to Tartine. Look at that huge line.

Example (18) indicates a belief that going to Tartine is a bad idea, but couches this belief in terms of the line outside Tartine, rather than the wait itself. In such a context, becoming aware of the proposition that there is a wait at Tartine would not obviously change any of my decisions.

Let's now revisit some of the cases that proved problematic for the alternative theories discussed above. First, consider repeated assertions of clarity, as shown in (12a) and (12b). Although (12a) raises awareness for all discourse participants that the woman is a doctor, this does not guarantee that all participants are also aware that the man is a doctor. Thus, there is nothing infelicitous about asserting (12b) following an assertion of (12a). Next, consider the assertion of the clarity of necessarily true propositions. Although a propositions is necessarily true, this does not guarantee that an agent is aware of it. Asserting the clarity of a necessarily true proposition can therefore function to raise awareness of it.

However, given what we have said above, making an agent aware of a proposition should generally only change their behavior if they had been making some implicit assumption regarding that proposition. We generally do not want to say that agents make implicit assumptions that necessarily true propositions are false, so it seems we have not explained the function of asserting the clarity of a necessarily true proposition. This issue can be resolved by allowing that unawareness without assumptions does not affect an agent's behavior in general, but that performing certain actions requires full awareness of a proposition. That is, for an agent to perform certain actions, belief without assumptions is not enough; instead, explicit belief is required. In particular, reasoning and drawing inferences would seem to require full awareness of both the premises and the conclusion. Therefore, in order to allow an addressee to successful reason about an issue, a speaker may need to raise the addressee's awareness of a particular proposition, even if the speaker did not take the addressee to be making an implicit assumption about this proposition. This explanation has an intuitive appeal for cases like (13), where it seems that the only reason to raise awareness of the proposition that n is divisible by 3 is to ensure that some inference is successfully performed.

For such cases, it appears that the proposal offered here closely resembles Bronnikov's in that asserting clarity plays the role of allowing the addressee to perform some inference. There is a similarity here, but note that the awareness-based proposal achieves this simply by having the addressee become aware of some proposition involved in the inference, while on Bronnikov's account, the

existence of such an inference is entailed by the truth conditions of *clear*. The awareness-based account achieves greater coverage in that it can explain the function of assertions of clarity in which it does not seem that the speaker necessarily wants the addressee to perform some inference, such as (16). In the context of (16), the speaker presumably wants to raise my awareness of the fact that it might be warmer in LA, since my behavior reflects an assumption that it will not be warmer. This does not require me to infer from some evidence that it might be warmer in LA, just to recognize that I am failing to consider important facts about weather.

The awareness-based account is also able to capture the fact that trivial assertions of clarity often seem odd, as pointed out by Bronnikov. After a speaker asserts that John ate a sandwich and a bag of chips (14a), we can assume that all speakers are aware that John ate a sandwich. Therefore, asserting that it is clear that John ate a sandwich (14b) should not alter any interlocutor's awareness state, and is therefore superfluous. However, I differ from Bronnikov in predicting (14b) to be true, but pragmatically odd, rather than infelicitous due to a presupposition failure.

Finally, we can consider cases of disagreement about clarity, as illustrated by (11). These are perhaps the hardest cases to capture on the proposal advanced here. Suppose B believes that Mindy is not a doctor, since she is smoking. After A asserts that it is clear that Mindy is a doctor, it cannot be clear to both A and B that Mindy is (or is not) a doctor. Thus, B's assertion should be not be interpreted such that the implicit experiencer of *clear* includes both A and B. Nonetheless, this seems to be the most natural way to interpret this utterance. What could be going on here?

Ultimately, the answer to this puzzle likely lies outside the scope of any analysis of *clear* in particular. Rather, resolving this issue seems to require a solution to notoriously difficult questions about faultless disagreement with predicates of personal taste and epistemic modals (Stephenson, 2007; von Fintel and Gillies, 2008; MacFarlane, 2011; MacFarlane, 2014). One possible answer to this question comes from von Fintel and Gillies (2011). Again assume that a speaker is licensed to assert simple clarity so long as they may outright assert personal clarity. Then, both A and B are licensed to assert simple clarity so long as it is clear to each of them that Mindy is (or is not) a doctor. But they may also interpret the other's assertion more broadly to mean that it is clear to both of them that Mindy is (is not) a doctor. By interpreting the other's utterance as such, both A and B might find themselves disagreeing with one another, although both of their assertions were licensed. A piece of evidence in favor of such an analysis is that A may respond to (11b) by denying that they ever asserted that it was clear to B that Mindy was a doctor.

(19)   Well, I never said it was clear *to you* that she's a doctor. Still, it's clear *to me* that she's a doctor.

Nothing about the disagreement in (19) violated what we have said so far regarding *clear*. In this case, we simply allow for two agents to maintain different, incompatible doxastic states.

5. Conclusion

To recap, we've seen two ways to resolve the paradox of asserting clarity outlined in §1. The first builds on the view that statements of simple clarity involve an implicit experiencer argument that is resolved contextually. When this argument is resolved in such a way that it does not include all discourse participants, assertions of simple clarity can be straightforwardly informative. The second resolution to this puzzle is based on an understanding of how assertions can raise awareness of propositions. Even when the context contains sufficient evidence to conclude some proposition p, this does not guarantee that all discourse participants are aware of p or are aware of the evidence supporting p. Asserting the clarity of p can ensure that all participants are aware of this proposition, which may have repercussions for these participants' behavior.

While the first resolution to the paradox of asserting clarity depends upon the particular lexical semantics for *clear* given in §2, the second resolution depends on much more general considerations about how speakers may manipulate the awareness of their interlocutors. Therefore, we should expect this sort of reasoning to extend to other cases in which assertions are seemingly uninformative, such as the following:

(20)   a. It's obvious that p.

      b. We all know that p.

      c. As you already know, p.

      d. Needless to say, p.

      e. …

These examples show that natural language is teeming with expressions that should be necessarily uninformative. For any of the expressions in (20), we could develop an argument similar to the paradox of asserting clarity. In each case, we may find that the use of these expressions is explained by their ability to raise awareness.[8]

A final question that arises from considering these uninformative expressions and their awareness-raising uses is why a speaker would ever choose to raise awareness using one of these devices rather than by simply asserting p outright. For example, if I want to raise your awareness that there is a wait at Tartine, why assert that it is clear that this is so, rather than simply asserting that it is so? An answer to this question comes from considering a listener's pragmatic reasoning about the possible intentions of a speaker who asserts p, as opposed to a speaker who asserts *It is clear that p*. If we take the implicit experiencer argument of *clear* to include both the speaker and the addressee, then an assertion of *It is clear that p* entails that the addressee believes p. Thus,

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[8]On the other hand, there are undoubtedly other uses of these expressions, as well as uses of *clear*, that are not fully captured by only considering their effects on agents' awareness. For example, all of these expressions seem to have a rhetorical effect of showing that the speaker takes the prejacent to be a settled matter.

a speaker making a clarity assertion communicates that they believe the listener to be (at least implicitly) informed with respect to p. In contrast, nothing similar is communicated by an outright assertion of p. Moreover, if clarity assertions or seemingly uninformative expressions like those in (20) are in pragmatic competition with an assertion of the prejacent, the latter may implicate that the speaker does *not* believe the listener to be informed about p. Assuming such an implicature has a social cost, assertions of clarity or assertions of the expressions in (20) should be the preferred way to raise awareness when the speaker takes the addressee to believe p.

In closing, it is important to note that the awareness-based analysis of clarity assertions joins a body of other recent work that has argued for the importance of incorporating notions of attention and awareness into understandings of semantics and pragmatics (Ciardelli, Jeroen Groenendijk, and Roelofsen, 2011; Franke and Jager, 2011; Roelofsen, 2013; Westera, 2013). This work challenges more conservative notions of the functions that different types of utterances can have in discourse. For example, the original articulation of the paradox of asserting clarity was motivated by a view of discourse according to which the only function of assertion is to inform one's interlocutors. The more liberal view offered here is not only useful for resolving puzzles such as that involving clarity assertions. It is also more psychologically realistic in that it recognizes well-known deficits of human cognition concerning memory and attention. Once these factors are acknowledged, it should come as no surprise that communicative systems would have ways to manage attention and awareness. We are likely to find more cases like the one discussed here in which aspects of natural language can only be fully understood once we acknowledge their awareness-managing functions.

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Do all languages make countability distinctions? Evidence from Nez Perce[1]

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Abstract. At first glance, Nez Perce looks like a language lacking any correlate of the traditional mass-count distinction. All Nez Perce nouns behave like canonical count nouns in three ways: all nouns combine with numerals without an overt measure phrase, all NPs may host plural features, and all NPs may host adjectives like *big* and *small*. I show that Nez Perce nevertheless makes two countability distinctions in noun semantics. A sums-based (cumulativity) distinction is revealed in the interaction of quantifiers with plural; a parts-based (divisiveness) distinction is revealed in certain quantity judgments. Both types of evidence involve complex structures to which language learners likely have little to no actual exposure. I suggest that Nez Perce furnishes a poverty of the stimulus argument in favor of semantic countability distinctions as a language universal.

Keywords: mass-count distinction, countability, variation, quantity judgment, cumulativity.

1. Introduction: two semantic countability distinctions

Early work on the semantic basis of the mass-count distinction emphasized two distinctive properties of mass nouns, one concerned with sums and one concerned with parts. The property concerned with sums was introduced by Quine (1960) as *cumulativity*; the property concerned with parts, as introduced by Cheng (1973), was dubbed *divisiveness* by Krifka (1989). In general terms:

(1)   A noun is cumulative iff it denotes a cumulative predicate.
      A predicate p is cumulative iff any sum of parts that are p is also p.

(2)   A noun is divisive iff it denotes a divisive predicate.
      A predicate p is divisive iff any part of something that is p is also p.

These properties describe patterns of inference: *water* (for instance) is cumulative because if a is water, and b is water, then $a + b$ is water. The major explanatory goal for a semantic account of countability distinctions has typically been to connect this type of inference to the morphosyntactic differences between the traditional classes of mass and count nouns. These include pluralization, combination with numerals, choice of quantifiers (*each, many, fewer* vs. *much, less*), and combination with 'count adjectives' (e.g. *small*). Both cumulativity and divisiveness have come in for their share of critique and controversy in this role. The result has been two kinds of advances.

First, one productive line of work has sought to refine the parts-based property in such a way

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as to avoid the so-called minimal parts problem. For Chierchia (2010), Landman (2011), and Grimm (2012), for instance, mass denotations may have minimal parts (and so are not properly divisive), but there nevertheless remains a parts-based property distinctive to mass nouns. Second, a complementary line of work has investigated the connections between cumulativity, divisiveness (or alternative parts-based notions), and particular morphosyntactic patterns. Here, a key role has been played by 'aggregate' nouns like *footwear, furniture* and *jewelry*. Such nouns occupy an intermediate place between canonical count nouns and canonical mass nouns in terms of inference: they are cumulative, but not divisive (or replacement notion). Notably, such nouns also occupy an intermediate place on distributional tests. Like canonical mass nouns, they lack plural forms, fail to combine with numerals directly, and combine with *much* and *less* instead of *many* and *fewer*. Yet like canonical count nouns, they combine with count adjectives (Schwarzschild's (2011) "stubs"):

(3) a. the small cat / the small furniture
     b. *the small water

In addition, as Barner and Snedeker (2005) discuss, aggregate nouns behave like canonical count nouns in the interpretation of comparative constructions like (4). The most natural interpretation of (4a) is numerosity-based: Mary has a greater number of cats, or greater number of pieces of footwear, than Sue does; the mass or volume of Mary and Sue's respective possessions does not matter. By contrast, the dominant interpretation of (4b) is mass- or volume-based: Mary has a greater mass or volume of water than Sue does, without regard to how many portions it comes in.

(4) a. Mary has more cats / footwear than Sue.
     b. Mary has more water than Sue.

These two advances together suggest that both sums- and parts-based distinctions have a role to play in explaining countability. We can retain the idea that mass nouns are distinguished by a parts-based property without requiring mass denotations to lack minimal parts *sensu stricto*. But we could not adopt *only* a parts-based distinction without losing sight of the special behavior of aggregate nouns. Aggregate nouns show us that noun denotations manifest not a two-way split, mass vs. count, but rather a three-way split, with nouns like *footwear* in the middle:

(5)

	CORE COUNT e.g. *cat*	AGGREGATE e.g. *footwear*	CORE MASS e.g. *water*
(a) pluralization	✓	*	*
(b) direct combination with numerals	✓	*	*
(c) quantifiers	*many, fewer*	*much, less*	*much, less*
(d) combination with count adjectives	✓	✓	*
(e) comparison based on ...	number	number	volume

The facts summarized in (5) suggest that plural, numerals, and quantifiers are regulated by a sums-based property (as in Chierchia 1998), whereas count adjectives and comparatives are regulated by a parts-based property (as in Bale and Barner 2009 and Schwarzschild 2011). Accordingly, if we take the relevant thesis about parts to be divisiveness, the three varieties of noun denotation can be sets of atoms for nouns like *cat*; atomic join semilattices for nouns like *footwear*; and nonatomic join semilattices for nouns like *water*. A picture along these lines is proposed by Doetjes (1997).[2]

2. The question, and a preview of the argument

One consequence of adopting a two-distinction theory of countability is a refinement of the questions to be asked about crosslinguistic variation. The proper question is not whether a given language (or indeed all languages) have *the* mass-count distinction, but rather what type(s) of countability distinctions a given language (or indeed all languages) make. We might probe the limits of crosslinguistic variability by asking a series of existence questions. For instance: Are there languages where no nouns are cumulative? Are there languages where all nouns are equally atomic?

Such questions are of course easier to answer in the affirmative than the negative. To give a negative answer, we must either exhaustively canvass the world's languages, or give a general argument that languages without countability distinctions cannot be acquired by humans. In the latter case, the argument turns on the poverty of the stimulus: even when faced with a data set that provides no major evidence for countability distinctions, learners nevertheless acquire a lexicon that encodes these distinctions in the semantics of nouns. This type of example would suggest that systems without semantic countability distinctions do not feature in the hypothesis space considered by children. And if this is so, there cannot be a language without semantic countability distinctions.

It is this type of argument to which I aspire in this paper. My discussion will center on Nez Perce, a language with no morphosyntactic evidence for a countability distinction in the obvious places – numerals, number marking, and count adjectives.[3] [4] I will show that Nez Perce nevertheless does encode a *semantic* distinction between nouns describing objects (i.e. core count nouns) and nouns describing substances (i.e. core mass nouns). The evidence for this distinction can only be found in grammatical configurations of a type which is essentially absent in corpora and daily conversation. The subtlety of the crucial evidence suggests that the acquisition of semantic countability distinctions in Nez Perce may not be attributable purely to linguistic experience on the part of the language learner. Instead, a linguistic universal is involved – one grounded in independently attested strategies used by learners to acquire the meanings of new words.

My argument proceeds as follows. In section 3, I present three *prima facie* arguments that all Nez

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[2]Schwarzschild's (2011) proposal is somewhat similar, though couched in an event semantics.

[3]Nez Perce is a highly endangered Sahaptian language spoken in Idaho, Washington, and Oregon, USA. The data in this paper were collected over five field trips, 2011-2015, from two native speaker consultants in Lapwai, ID, USA.

[4]The argument is extended to Yudja, described by Lima (2014) as lacking countability distinctions, in Deal (To appear). Also discussed there is Mandarin, which makes a parts-based distinction only (Doetjes, 1997).

Perce nouns have the same type of semantic analysis. For the distribution of numerals, number marking, and count adjectives, we will see that all Nez Perce nouns behave like core English count nouns. In section 4, I propose an analysis of these facts that nevertheless lexically encodes both parts- and sums-based distinctions between object nouns and substance nouns. I then present the evidence that these distinctions are indeed required, in sections 5 (sums) and 6 (parts). In section 7 I discuss the availability of this evidence to the learner, and conclude.

3. Nez Perce: a language with no countability distinctions?

Contemporary Nez Perce is not a classifier language (Deal, 2016); nouns may combine with numerals without any overt classifying or measuring expression. The direct combination of an object NP with a numeral is seen in Nez Perce examples (6).[5]

(6) a. mitaat nicka'niicka'   b. naaqc himeeq'is walc
         three   strawberry   one   big   knife
         3 strawberries   1 big knife

This behavior is familiar for object nouns in non-classifier languages. By contrast, in familiar non-classifier languages, substance nouns may combine with numerals directly iff the noun is coerced into countability – that is, iff it is interpreted as a property of subkinds of the stuff present in the substance denotation (sorting), or as a property of conventionally packaged units of the stuff present in the substance denotation (packaging). There is an extensive literature on coercion of both types (e.g. Pelletier and Schubert (2003), Grimm (2012: §3.6.3), and references there).

In Nez Perce, the combination of substance nouns with numerals is by outward appearances just as direct as for object nouns; however, this combination does not depend on any familiar type of coercion. In (7a), *'itx* 'clay' combines with a numeral, and the interpretation involves counting two portions of clay. Both are of the same type of clay, and neither is a conventional package. Compare, in this context, English (7b).

(7) a. (Speaker is toying with two nearly identical pieces of white modeling clay.)
         'Ee   wee-s   **lepit 'itx̂**, kii   kaa yox̂.
         2SG.CLITIC have-PRES two   clay, DEM and DEM.
         You have two pieces of clay, this one and that one.
     b.   # You have two clay(s).

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[5]The following abbreviations are used in glosses: CISLOC cislocative, COMP comparative, DEM demonstrative, GEN genitive, HUM human, IMPER imperative, P perfect/perfective aspect (see Deal 2010: §2.3), PL plural, PRES present tense, REM.PAST remote past tense, SG singular, 2/1 2nd person subject and 1st person object portmanteau agreement, 3SUBJ 3rd person subject agreement.

Likewise, in (8a) and (9a), *tuutnin'* 'flour' and *kike't* 'blood' combine with numerals, and the interpretation involves counting by piles or drops of the substance. Compare (8b) and (9b).

(8)   a.   (Describing a photograph of a pile of flour on a table)
           Naaqc himeeq'is x̂ayx̂ayx̂ tuutnin' hii-we-s.
           one   big   white   flour   3SUBJ-be-PRES
           There's one big pile of white flour.
      b.   # There's one big white flour.

(9)   a.   (Discussing a nosebleed)
           Lepit kike't hi-sew-n-e.
           two   blood   3SUBJ-fall-P-REM.PAST
           Two drops of blood fell.
      b.   # Two blood(s) fell.

These data show that it is possible to count substances in Nez Perce by the portions the substance occurs in, even when these portions do not represent distinct subkinds and do not correspond to conventional packages. The pattern holds for substances of various types, including flexible solids (clay), powders (flour), and liquids (blood).

We turn now to number marking. Like many languages, Nez Perce marks plural not just on nouns but also on nominal modifiers and verbs. That is, it is a language with number agreement and number concord. Compare singular (10a) to plural (10b), where plural is marked on four different lexical items (bolded).

(10) a.   Yox̂ kuhet 'aayat hii-we-s   'eemti.
           DEM tall   woman 3SUBJ-be-PRES outside
           That tall woman is outside.
      b.   Yox̂-**me ki**-kuhet **ha**-'aayat hi-w-s-**iix**   'eemti.
           DEM-PL PL-tall   PL-woman 3SUBJ-be-PRES-PL outside
           Those tall women are outside.

Following Sauerland (2003), I will assume that at most one [PL] feature is semantically interpreted per plural nominal, even though plural may be exponed multiple times.[6] Following Ritter (1991) and many others, I assume that this single [PL] feature originates on a functional head in the nominal projection. The syntax and LF structures I adopt for the subjects of (10a,b), respectively, are shown in (11a,b). (The absence of a [PL] feature on Num is indicated with a dash.)

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[6] The precise conditions on this multiple exponence are explored in Deal 2016.

(11)   a.   [*yox̂* 'that'   [Num: –   [*kuhet* 'tall'   *'aayat* 'woman']]]
       b.   [*yox̂* 'that'   [Num: [PL]   [*kuhet* 'tall'   *'aayat* 'woman']]]

From this perspective, information about the plural *form* of the noun *per se* is not available to the semantics. Morphological form is a PF matter, determined in a PF component of grammar. This means we must recast the traditional idea that a noun's meaning determines whether it has a plural form. What a noun's meaning determines is whether or not it may co-occur with a plural Num head in its nominal projection. When a noun co-occurs with a plural Num head, a [PL] feature is present for interpretation at LF and potentially at PF as well.

On the assumption that plurality is a feature of nominal projections, rather than nouns themselves, there is no particular reason to limit our attention to *noun* morphology when we seek PF evidence for the presence of [PL] in a particular language. A plural affix on a noun furnishes one type of evidence that the nominal contains a [PL] feature, but so does a plural affix on a nominal modifier.

In Nez Perce, the morphology of nouns themselves proves a limited diagnostic for [PL] features in view of an interaction between number marking and animacy (gender). I have shown elsewhere that plural marking on nouns in this language is tightly constrained by animacy (Deal, 2016). The nouns that show plural marking all belong to the human class, a pattern that is crosslinguistically common.[7] A representative selection of nouns with morphological plural forms is given in Deal 2016: (33); these include *'aayat* 'woman', *haama* 'man', *teeq'is* 'elder'. In nominals headed by these nouns, noun morphology provides evidence regarding the presence of [PL] on Num. Nouns outside the human class, however, do not possess plural forms. In nominals headed by nouns like *picpic* 'cat', *'imes* 'deer', *piswe* 'rock', *timaanit* 'apple', or *kuus* 'water', noun morphology provides no evidence regarding [PL] on Num. We must look for evidence of a different type.

This evidence comes from adjective inflection. Many (though not all) Nez Perce adjectives have plural forms. Like in many languages, plural marking on adjectives uses the same set of affixes used for plural on nouns (*-me*, *he-* and reduplicative *Ci-*; see Deal 2016). Also like in many languages, both singular and plural forms exist for a range of adjectives expected to be inherently distributive, such as *kuhet* 'tall', *cilpcílp* 'round', and *limeq'is* 'deep'. Finally, plural adjectives cannot be used in nominals that are otherwise unambiguously singular. Example (12) features a human-class noun, *'aayat* 'woman', which possesses a plural form; when the plural form of this word is not used, the nominal must be singular. In this context, a plural adjective cannot be used. Contrast (10b), where the noun form is plural and the plural adjective is acceptable. These facts together make it clear that adjectives mark a contrast of number, rather than (say) distributivity.

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[7]In Nez Perce, the implication does not work in reverse; some human-class nouns lack plurals. Note as well that Nez Perce plural markers do *not* encode definiteness along with plurality. See Deal 2016 for discussion.

(12)   Yox̂   kuhet / *ki-kuhet 'aayat   hii-we-s   'eemti.
       DEM tall   / *PL-tall   woman.SG 3SUBJ-be-PRES outside
       That tall woman is outside.

Plural marking on attributive adjectives is unrestricted by the animacy class of the head noun. Plu-
ral adjectives modifying inanimate-class nouns are particularly interesting, as in this case, plural is
expressed morphologically *only* on the adjective. In (13), the subject is headed by inanimate-class
noun *taam'am* 'egg', which has no plural form. The form of N itself therefore provides no evi-
dence about the presence of a [PL] feature. The plurality of the argument is visible morphologically
only on the plural adjective, bolded. (Compare English *These deer ran*, where plurality is visible
morphologically only on the demonstrative.)

(13)   Himeeq'is 'itet'es-pe hii-we-s   [**ki-kuckuc** taam'am].
       big   bag-in   3SUBJ-be-PRES PL-small   egg
       In the big bag there are little eggs.

This type of data reveals that any Nez Perce argument, regardless of animacy, may contain [PL].
I propose that the LF structure of an inanimate plural nominal and an animate plural nominal are
parallel; the difference is at PF only. Compare the LF structure of the subject of (10b), introduced
above, to the LF structure of the subject of (13):

(14)   a.   [*yox̂* 'that'   [Num: [PL]   [*kuhet* 'tall'   *'aayat* 'woman'   ]]]   (10b)
       b.   [Num: [PL]   [*kuckuc* 'small'   *taam'am* 'egg']]   (13)

With this background, let us turn our focus to plural adjectives as a distributional diagnostic for
countability distinctions. Plural adjectives allow us to ask whether Nez Perce shows a distinction
within the inanimate class akin to English *table/tables, blood/*bloods*. What we find is that NPs
consistently permit [PL] in Nez Perce, regardless of whether the head noun is a substance noun or
an object noun. Plural substance NPs describe pluralities of portions of the substance. In (15a),
plural occurs in an NP headed by *sit̂x* 'mud'; the example introduces a plurality of portions of red
mud. Again, familiar packaging and sorting coercions are not involved; these portions are of the
same subkind and do not correspond to conventional packages.

(15)   a.   (Discussing road construction)
            He-'ilp-e-'ilp sit̂x   hii-we-s   x̂uysx̂uys 'iskit-pe.
            PL-red   mud 3SUBJ-be-PRES slippery   road-on
            There are red muddy spots that are slippery on the road.
       b.   # Red muds are slippery on the road.

(See Deal (To appear) for further examples.) Overall, once we know where to look for a distributional distinction in number marking in Nez Perce – namely, on attributive adjectives – we see that substance nouns and object nouns behave entirely the same.

So far, in considering numerals and plural, we have considered evidence bearing on a sums-based countability distinction. A parts-based distinction can be assessed distributionally by looking at count adjectives. In Nez Perce, count adjectives may combine both with substance nouns and with object nouns. *Himeeq'is* 'big', for instance, may combine with substance noun *kuus* 'water' to describe a big puddle or portion of water. Compare Nez Perce (16a) to English (17).

(16)   a. himeeq'is kuus   *cf.*   b. himeeq'is picpic
           big   water   big   cat
           (the) big portion of water   (the) big cat

(17)   # big water

4. A modest proposal

In terms of combination with numerals, the distribution of [PL], and count adjectives, all Nez Perce nouns behave like English core count nouns. The denotations of English core count nouns are quantized; they are neither cumulative nor divisive. One possible conclusion, given the facts of the previous section, is that all nouns in Nez Perce are lexically quantized. Another possibility is that Nez Perce substance nouns are not inherently quantized, but are subject to a very general mapping into quantized denotations. In this section I flesh out this latter idea.

I start with the proposal that object nouns in Nez Perce have a special status: they alone denote sets of atoms in their root form. By 'root form' I mean the core open-class lexical representation of the noun, which may or may not be semantically equivalent to the noun root once it has combined with various (perhaps silent) pieces of functional morphology. Following the practice of Distributed Morphology, I will indicate noun roots using the symbol $\sqrt{}$. In this notation, my proposal is that roots like $\sqrt{picpic}$ 'cat' and $\sqrt{tiim'en'es}$ 'pencil' have quantized denotations.

In contrast to object nouns, the roots of substance nouns do not denote sets of atoms; their denotations are homogeneous (both cumulative and divisive). On this hypothesis, the meanings of core English count roots and mass roots are (in mereological terms) identical with those of their Nez Perce counterparts: $\sqrt{cat}$ and its Nez Perce counterpart $\sqrt{picpic}$ both have quantized denotations, whereas $\sqrt{blood}$ and its Nez Perce counterpart $\sqrt{kike't}$ both have homogeneous denotations.

(18) $[\![\sqrt{cat}]\!] = [\![\sqrt{picpic}]\!] =$ (the characteristic function of) the set of all cat-atoms

(19) $[\![\sqrt{blood}]\!] = [\![\sqrt{kike't}]\!] =$ (the characteristic function of) the set of all portions of blood

Pluralization and counting with substance nouns is more flexible in Nez Perce than in English because Nez Perce allows a more general type of homogeneous→quantized meaning shift than English does. The shift that Nez Perce makes available is fully productive (unlike English packaging and sorting coercions), so there is little cause to record it in the lexical entries of nouns. In principle, it could be accomplished purely in the semantic component, by the analogue of a type-shifting rule; it could alternatively be accomplished in the ordinary compositional semantics with the help of a silent syntactic piece. I will provide an implementation of the latter type.

My proposal, then, is that pluralization and counting with substance nouns involves a silent piece α_n, which attaches between the core NP and numerals, [PL], or count adjectives. The role of α_n is to map homogeneous denotations to quantized ones. This mapping must make room for context sensitivity: *'ipeex̂* 'bread', for instance, can take on a quantized denotation consisting of bread loaves, or one consisting of bread slices.

(20)   a.   Out of the blue: 'Iin-im   wee-s   piilept 'ipeex̂.
                               1SG-GEN have-PRES four   bread
                               (lit. I have four bread.)
            ARD: Would you think I have four slices or four loaves?
            Speaker: Four loaves.
       b.   We are making sandwiches and I say: Pii-'ni-m   lepit 'ipeex̂!
                                                   2/1-give-CISLOC.IMPER two bread
                                                   (lit. Give me two bread!)
            ARD: What would you give me?
            Speaker: If I heard that, I'd probably figure you wanted slices.

Let us then treat α_n as introducing a variable over atomization functions AT. At minimum, an atomization function must meet two conditions: atoms must instantiate the property of which they are an atomization, and no element of an atomization may have a proper part which is also an element of that atomization. (22b) ensures that the atomization of any property is quantized.

(21) $[\![\alpha_n]\!]^g = \lambda P \lambda x . AT_n(P)(x)$ *where $AT_n = g(n) = $ the nth atomization function*

(22)   Conditions on atomization functions:
       a. $AT_n(P)(x) \rightarrow P(x)$
       b. $AT_n(P)(x) \rightarrow \neg\exists y[y \neq x \wedge y \leq x \wedge AT_n(P)(y)]$

We will now see how this proposal accounts for combinations of substance nouns with numerals, [PL], and count adjectives. Substance root $\sqrt{kike't}$ 'blood' combines with a numeral in (9a), repeated below along with the LF structure of the substance nominal. (I assume, following Krifka (1989), that no [PL] feature is present at LF in nominals with numerals. Morphological plural as

in *two cats* results from PF agreement processes.) Sentence (23a) is true in a context iff there are at least two elements of the contextually-provided atomization of *blood* that fell.[8]

(23) a. Lepit kike't hi-sew-n-e.
          two   blood 3SUBJ-fall-P-REM.PAST
          Two drops of blood fell.

      b. [*lepit* 'two' [Num:− [α_n $\sqrt{}$*kike't* 'blood']]

(24) $|\{x : AT_n(blood)(x) \wedge fell(x)\}| \geqslant 2$

Substance root $\sqrt{}$*sitx̂* 'mud' combines with plural in (15a), repeated below along with the LF structure of the substance nominal. (I depict the adjective $\sqrt{}$*'ilp'ilp* 'red' as attaching below α_n, but this choice is not crucial.) Supposing plural contributes Link's (1983) * operator (simple closure under sum), the sentence is true iff there is an element of $^*AT_n(\lambda x.red(x) \wedge mud(x))$ that is slippery on the road, (26).

(25) a. He-'ilp-e-'ilp **sitx̂** hii-we-s   x̂uysx̂uys 'iskit-pe.
          PL-red   mud 3SUBJ-be-PRES slippery   road-on
          There are red muddy spots that are slippery on the road.

      b. [Num: [PL] [α_n $\sqrt{}$*'ilp'ilp* 'red' $\sqrt{}$*sitx̂* 'mud']]

(26) $\exists y[^*AT_n(\lambda x.red(x) \wedge mud(x))(y) \wedge$ *slippery-on-the-road*$(y)]$

Finally, substance root $\sqrt{}$*kuus* 'water' combines with a count adjective in (16a), again repeated below with its LF structure. (I ignore the possible definite reading here, which presumably results either from a null D or from an ι type-shift.)

(27) a. himeeq'is kuus
          big   water
          (the) big portion of water

      b. [$\sqrt{}$*himeeq'is* 'big' [α_n $\sqrt{}$*kuus* 'water']]

We learn from examples like *small furniture* that count adjectives do not require their complements to be quantized *per se*; their distinctive property relates strictly to parts, rather than to sums. For concreteness, let us suppose that adjectives like *himeeq'is* 'big' lexically presuppose that their complements' denotations contain minimal parts, (28). Unlike $\sqrt{}$*'ilp'ilp* 'red' in (25), which in principle could attach either above or below α_n, $\sqrt{}$*himeeq'is* 'big' can only attach above α_n, where its complement denotes $\lambda x.AT_n(water)(x)$. Thus (27b) denotes the property of being big and an element of the contextually-provided atomization of *water*, (29).

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[8]Note that $\geqslant$ in (24) represents the inequality relation, by contrast to the mereological parthood relation $\leq$.

(28) $\llbracket\sqrt{big}\rrbracket = \llbracket\sqrt{himeeq'is}\rrbracket =$
$\lambda P\lambda z : \exists X[X \neq \emptyset \wedge \forall x \in X[P(x) \wedge \neg\exists y[y \neq x \wedge y \leq x \wedge P(y)]]]. P(z) \wedge big(z)$

(29) $\lambda z.AT_n(water)(z) \wedge big(z)$

We have now seen how the results of the previous section can be made compatible with the hypothesis that Nez Perce indeed makes semantic countability distinctions in its nominal lexicon. On this hypothesis, Nez Perce nouns come to denote sets of atoms in two distinct ways. Object nouns are born that way – their roots come from the lexicon already quantized – but substance roots must use α_n. Nouns also come to have cumulative denotations in two distinct ways. Substance nouns are born that way – their roots come from the lexicon already homogeneous – but object roots must combine with a semantically interpreted [PL]. The situation is summarized in table (30).

(30)

Denotation is a set of atoms	Denotation is a join semilattice
Substance root + α_n	Substance root by itself
Object root by itself	Object root + [PL]

On this approach, the reason that Nez Perce appears to lack any countability distinctions is simply that α_n is always inaudible. The complements of numerals, [PL] Num, and count adjectives are all environments in which a nominal denotation must come from the left-hand column in (30). It happens that Nez Perce morphology does not visibly distinguish the simplex forms in this column (object roots) from the complex ones (substance roots + α_n).

It is time now to consider the right-hand column in (30) – the column which crucially features [PL]. Unlike α_n, [PL] is an element that Nez Perce sometimes makes overt. To see a first difference emerge between object and substance roots, we need to find an area of the grammar that calls for cumulative predicates. Object roots should require plural in such cases, but substance roots should not. Quantificational structures provide the environment that bears out this prediction.

5. Cumulativity and the quantifier system

Nez Perce has six D-quantifiers. Two of these are universal quantifiers (the difference between which is not presently clear); others are translation equivalents of 'a lot / many / much', 'a few / a little', 'how many / how much', and a partitive 'some'.[9]

(31)

'oykala	la'am	'ilex̂ni	miil'ac	mac	tato's
all$_1$	all$_2$	a lot	a few/little	how many/much	some (of)

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[9]All quantifiers show a special form for gender concord with [+HUMAN] nouns, featuring an agreement suffix which is underlyingly *-me* or *-we*. Gender concord with [+HUMAN] nouns is generally optional (see Deal 2016).

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Do all languages make countability distinctions? Evidence from Nez Perce

All quantifiers combine with all nouns, and (crucially) all quantifiers require cumulative complements. We will now see that object- and substance-roots give rise to cumulative NPs in different ways. Object roots require [PL] to be cumulative, but substance roots are simply born cumulative.

All quantifiers require their object NP complements to contain [PL]. Accordingly, nouns that have plural forms must take those forms when preceded by a quantifier, (32). Recall that all such nouns are [+HUMAN]. Plural is also morphologically visible if the NP contains an adjective, as in (33); the plural form of the adjective is systematically preferred in [Q A N$_{object}$] constituents. The schematic LF structure of these examples is shown in (34). Overall, we see a consistent pattern across the set of object nouns: [PL] must be present in the complement of a quantifier.

(32) a. 'oykal-o ha-'aayat/*'aayat
         all$_1$-HUM PL-woman/*woman.SG
         all the women

      b. 'ilêxni ha-ham/*haama
         a.lot   PL-man/*man.SG
         a lot of men

(33) a. 'oykala $^{??}$k'uupnin' / k'i-k'uupnin' tiim'en'es
         all$_1$ broken   / PL-broken   pencil
         all broken pencils

      b. 'ilêxni $^{??}$tiyaaw'ic / ti-tiyaw'ic wix̂si'likeecet'es
         a.lot $^{??}$sturdy   / PL-sturdy chair
         a lot of sturdy chairs

(34) [Q [Num: [PL]   [($\sqrt{}$ADJECTIVE) $\sqrt{}$OBJECT-ROOT]]]

The behavior of substance NPs with quantifiers is sharply contrasting. *All quantifiers combine with substance NPs that do not contain* [PL]. Here, there is no preference for plural adjectives:

(35) a. 'oykala ta'c hipt
         all$_1$ good food
         all good food

      b. 'ilexni yoosyoos tiipip
         a.lot   blue   frosting
         a lot of blue frosting

The LF structure of these examples contrasts with (34) in lacking a [PL] feature on Num. Num contains no contentful features in this case:

(36) [Q [Num: –   [$\sqrt{}$ADJECTIVE $\sqrt{}$SUBSTANCE-ROOT]]]

These facts show that what Nez Perce quantifiers require of their complements is not plurality but cumulativity. They require object roots to combine with plural, but they impose no such requirement on substance roots. The pattern is one familiar from quantifiers in various languages,

including English. It is precisely the contrast between *all blood* and *all cat*(s)*. Nez Perce presents a highly generalized version of this pattern, extending it to all D-quantifiers.

The data thus far concern whether [PL] is *mandatory* in the complement of a quantifier, not whether it is merely possible. Should we expect [PL] to be available in the complement of a quantifier when the root is a substance noun? Indeed we should, given that substance roots may freely combine with α_n. A substance root in combination with α_n has a non-cumulative denotation, like an object root on its own. Accordingly, it must combine with [PL] in a quantifier complement.

As expected, we find that substance roots may coexist with [PL] in quantifier complements, and whenever they do, an atomized reading surfaces for the substance noun. Compare (37), with a non-plural adjective and a substance noun, to the minimally different (38), where the adjective is marked plural. In (37), the quantifier is able to combine directly with the NP because the NP denotation is cumulative. Num contributes no content. In (38), by contrast, the substance NP combines with α_n, inducing an atomization of $\lambda x.black(x) \wedge fabric(x)$. The atomized property is not cumulative and therefore must combine with plural before it combines with the quantifier.

(37)   a.   'ilex̂ni cimuuxcimux samq'ayn
           a.lot   black   fabric
           a lot of black fabric

        b.   [Q [Num: –   [$\sqrt{}$*cimuuxcimux* 'black' $\sqrt{}$*samq'ayn* 'fabric']]]

        c. $Q(\lambda x.black(x) \wedge fabric(x))$

(38)   a.   'ilex̂ni cicmuxcicmux samq'ayn
           a.lot   PL.black   fabric
           a lot of pieces of black fabric

        b.   [Q [Num: [PL]   [α_n [$\sqrt{}$*cimuuxcimux* 'black' $\sqrt{}$*samq'ayn* 'fabric']]]]

        c. $Q(^*AT_n[\lambda x.black(x) \wedge fabric(x)])$

The overall empirical picture on combinations of quantifiers, adjectives and nouns is summarized in table (39). LF structures for the three well-formed options are given in (34) (cell B), (36) (cell C) and (38b) (cell D). The missing cell, cell A, corresponds to LF structure (40).

(39)   Quantifier, adjective, noun: grammaticality judgments

	Q A(non-pl) N	Q A.pl N
Complement headed by object $\sqrt{}$	* CELL A	✓ CELL B
Complement headed by substance $\sqrt{}$	✓ CELL C	✓ (α-based structure) CELL D

(40)   [Q   [Num: –   [$\sqrt{}$ADJECTIVE $\sqrt{}$OBJECT-ROOT]]]   ✗

Structure (40) is ill-formed because the complement of the quantifier is not cumulative. The crucial contrast is between this structure and the minimally different (36) with a substance root. The contrast is explained by treating object roots as basically quantized and substance roots as basically cumulative. In sum: Nez Perce has a countability distinction in terms of cumulativity.

6. Divisiveness and quantity comparatives

Recall that comparatives furnish a diagnostic for minimal parts based on the particular scale involved in the comparison. In English, quantity comparisons with nouns like *cat* and *footwear* are assessed on a scale of numerosity, whereas those with nouns like *water* are assessed on a scale of volume. According to Bale and Barner (2009), comparatives like (4) involve a measure function variable μ, relating the set of cats/instances of footwear/portions of water that Mary has and the set of cats/instances of footwear/portions of water that Sue has. Iff the two sets contain atoms, μ is fixed as the numerosity comparison function m_1. Otherwise, μ is contextually determined, and may be fixed in various contexts as volume comparison, etc.

(41) $m_1(X)(Y) = 1$ iff X and Y are join semi-lattices and $|\{x : x \text{ is an atom in } X\}| > |\{y : y \text{ is an atom in } Y\}|$

In Nez Perce, quantity comparatives are formed using the quantifier *'ilex̂ni* 'a lot' together with comparative word *qetu* '-er'.[10] A simple example featuring a substance noun is provided in (42). (For reasons to become clear, I temporarily withhold a free translation.)

(42)   A-nm   'uu-s   qetu   'ileX̂ni kuus   B-x.
       A-GEN have-PRES COMP a.lot   water B-from

Suppose the measure of comparison for this example is numerosity: A must have more portions of water than B does. This suggests that the two sets under comparison contain atoms. But how does the grammar provide these two sets? One possibility is that $[\![\sqrt{kuus}]\!]$ 'water' contains atoms; the noun combines directly with *qetu 'ileX̂ni* 'more'. On this hypothesis, the atoms used for numerosity comparison come directly from the root denotation. Another possibility is that $[\![\sqrt{kuus}]\!]$ 'water' is homogeneous and the combination of the noun and quantifier is mediated by α_n; the atoms used for numerosity comparison come from α_n in combination with the root.

Our investigation of quantifiers and cumulativity has revealed a method for empirically distinguishing these two hypotheses. We have seen that all Nez Perce quantifiers require their complements

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[10]This corresponds straightforwardly to Bresnan's (1973) decomposition of English *more* as *many/much* + *-er*. Similarly, Nez Perce 'less' comparatives feature *qetu* '-er' plus *miil'ac* 'few/little'.

to be cumulative. This holds of *'ileẍni* 'a lot'; presumably it holds no less of complex quantifier *qetu 'ileẍni* 'more'. If the complement of *qetu 'ileẍni* 'more' must be cumulative, it cannot simply consist of a substance root plus α_n. [PL] must be present in the complement of the quantifier whenever α_n is. The two candidate LFs for the relevant portion of (42) are thus as shown in (43). When adjectives are introduced, the result is (44), matching what we saw in (37b) and (38b).

(43) a. **Hypothesis 1:** [*qetu 'ileẍni* 'more' [Num: -   [√*kuus* 'water']]]
      b. **Hypothesis 2:** [*qetu 'ileẍni* 'more' [Num: [PL] [α_n √*kuus* 'water']]]

(44) a. [Q [Num: –   [√ADJECTIVE   √SUBSTANCE-ROOT]]]
      b. [Q [Num: [PL] [α_n [√ADJECTIVE   √SUBSTANCE-ROOT]]]]

Structures (44) are empirically distinguishable: the presence of an adjective makes it possible to morphologically assess whether or not [PL] is present. In turn, if we know that [PL] is present with a substance root in a quantifier complement, we know that α_n is present. We can therefore assess the hypothesis that numerosity comparison with substance nouns requires α_n by assessing whether numerosity comparison with substance nouns requires an adjective to mark plural.

Here are the predictions, in sum: if ⟦√*kuus*⟧ 'water' is atomic (cf. ⟦√*furniture*⟧), then numerosity comparison should be possible in structure (44a). In this structure an adjective cannot be marked plural. (There is no [PL] feature to be transferred to the adjective by concord.) If, on the other hand, ⟦√*kuus*⟧ 'water' is non-atomic (cf. ⟦√*water*⟧), numerosity comparison should be possible only in structure (44b). In this structure an adjective must be marked plural.

These predictions were tested using the quantity judgment paradigm introduced by Barner and Snedeker (2005). Seven test stimuli were constructed, featuring seven substances named by common Nez Perce words: dirt (*'itẍ*), flour (*tuutnin'*), milk (*qahas*), cloth (*samq'ayn*), paper (*tii'men'es*), water (*kuus*) and sugar (*cicyuuk'is*). Each stimulus showed one side with a larger number of portions and one side with a greater overall volume of substance. The stimuli consisted of photographs on a wooden surface. Two example stimuli are shown in (45a,b). In addition to these test items, 10 additional stimuli were constructed, featuring objects rather than substances. An example is shown in (45c). The 17 photographs were arranged in pseudo-randomized order, varying objects versus substances as well as the side of the larger object/portion.

(45)   Sample photos used in quantity judgment task
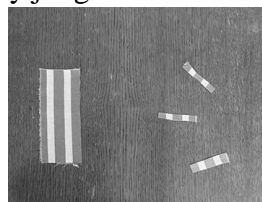
(a) *qahas* 'milk'   (b) *samq'ayn* 'fabric'   (c) *sooẍ* 'spoon'

While looking at each picture, Nez Perce speakers provided answers to quantity judgment questions featuring adjectives and nouns. In line with previous findings, quantity judgments with object nouns were reliably assessed in terms of number. Recall that a [Q A N_{object}] constituent always requires the adjective to be plural (table (39)). A question with an object root is shown in (46) with the corresponding schematic LF. Comparison in terms of numerosity is correctly predicted here because $[\![\sqrt{\textit{'ileeptik'ey}}]\!]$ 'sock' contains atoms.

(46) Object root condition

    a. 'Isii-nm   'uu-s   qetu 'ilex̂ni ti-ta'c   'ileeptik'ey?
        who-GEN have-PRES COMP a.lot   PL-good sock?
        Who has more good socks?

    b. [*qetu 'ilex̂ni* 'more'   [Num: [PL]   [$\sqrt{}$ADJECTIVE $\sqrt{}$OBJECT-ROOT]]]

When a quantifier's complement is headed by a substance noun, an adjective contained in that complement need not be plural (see table (39)). To assess the atomicity of substance root denotations, the baseline condition, shown in (47), was a plural adjective condition. (The pluralized adjective is bolded.) Plural morphology on the adjective indicates the presence of [PL]; in a quantifier complement headed by a substance noun, this requires α_n.

(47) Plural adjective / substance root condition

    a. 'Isii-nm   'uu-s   qetu 'ilex̂ni **ti-ta'c** qahas?
        who-GEN have-PRES COMP a.lot   PL-good milk?
        Who has more portions of good milk?

    b. [*qetu 'ilex̂ni* 'more'   [Num: [PL]   [α_n [$\sqrt{}$ADJECTIVE $\sqrt{}$SUBSTANCE-ROOT]]]]

Given that α_n is present, the complement of the quantifier has atoms in its denotation, and numerosity-based answers are predicted. This prediction is borne out: answers in the plural adjective / substance noun condition were strictly based on numerosity, not volume (100% of responses).

To compare Hypotheses 1 and 2 in (43)/(44), the crucial test case is the non-plural adjective / substance root condition, (48). Here, the absence of plural morphology on the adjective indicates the absence of [PL]. Without [PL], α_n cannot be present in a quantifier complement. Therefore, the interpretation of the quantity comparison must be based on the denotation of the root alone.

(48) Non-plural adjective / substance root condition

    a. 'Isii-nm   'uu-s   qetu 'ilex̂ni **ta'c** qahas?
        who-GEN have-PRES COMP a.lot   good milk?
        Who has more good milk?

    b. [*qetu 'ilex̂ni* 'more'   [Num: −   [$\sqrt{}$ADJECTIVE $\sqrt{}$SUBSTANCE-ROOT]]]

The finding in this condition contrasts markedly with the plural adjective / substance root condition (47). Answers in the non-plural adjective / substance root condition were based strictly on volume, rather than numerosity (100%). This provides evidence that substance roots by themselves do not have denotations that include atoms. That contrasts with object roots, as shown in (46). The results are summarized in table (49).

(49)   Quantifier, adjective, noun: interpretation of comparison

	Q A(non-pl) N	Q A.pl N
Complement headed by object $\sqrt{}$	n/a (ill-formed)	**number** (46)
Complement headed by substance $\sqrt{}$	**volume** (48)	**number** (47)

The findings should be contrasted with the predictions that would be made if all nouns had atomic denotations in Nez Perce: we would expect numerosity-based comparison across the board. In actual fact, numerosity comparison somehow becomes unavailable when the quantity judgment question contains a substance root with a non-plural adjective. The overall conclusion is that Nez Perce noun roots show a countability distinction in terms of minimal parts.

7. Implications

The subtlety of the evidence for countability distinctions in Nez Perce raises serious questions for language acquisition. How exactly do learners arrive at quantized denotations for object roots but homogeneous denotations for substance roots? Must they consider (and somehow rule out) the hypothesis that the language they are learning has no countability distinctions at all? The decision could be made on the basis of linguistic input only if learners have sufficient exposure to [Q A N] constituents. A corpus study of the largest collection of Nez Perce texts suggests that learners may have little to no exposure of this type. Of the 403 quantifiers identified in the corpus, none occurred in a [Q A N] constituent (Deal To appear).

The alternative hypothesis is that learners do not acquire semantic countability distinctions from primary linguistic input. The distinctions arise instead from basic mechanisms of language acquisition. Soja et al. (1991) and Chierchia (1994) discuss a mechanism of precisely the relevant type. To acquire root meaning early in acquisition, children build on the cognitive distinction between substances and objects. When a new noun describes an object, they conclude that the extension of the root consists of atoms of the same type as that object. When a new noun describes a sample of substance, they conclude that the extension of the root consists of a homogeneous join semilattice of stuff of the same kind as that substance. If these strategies are *independent of* exposure to any particular language and *carried out prior* to the point at which children master the morphosyntax of countability (as Soja et al.'s experimental findings suggest), then we expect the resulting semantic encoding of countability distinctions to be a language universal.

This final conclusion does *not* mean, in Chierchia's (2010) terms, that "every language encodes [countability distinctions] in a number of conspicuous morphosyntactic ways." Nez Perce in fact shows us that that type of obvious encoding cannot be taken for granted. The real universal is more subtle and more interesting. It is in what nouns mean, not directly in their surface distribution. Only where we can actually tell apart root semantics from the semantics of roots plus hidden functional morphology should we expect to see a countability distinction universally emerge.

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Factivity in German Exclamatives[1]

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Abstract. This paper explores the information structural status of exclamative utterances. Specifically, it addresses the issue of whether the propositional content of exclamatives is factive or not. I argue that standard factivity tests are not able to provide an answer to this question because either they are unreliable or they cannot be applied to exclamatives. I propose a new test that involves VERUM focus: exclamatives show the same kind of VERUM focus distribution as factive complements. Furthermore, focus on the illocution of exclamatives does not emphasize the truth of the proposition, contrary to illocution focus in assertions.

Keywords: exclamatives, German, factivity, presupposition, VERUM focus

1. Introduction

Exclamatives come in a great variety of syntactic forms. In this paper I focus on *wh*-exclamatives, polar exclamatives and German *that*-exclamatives.

(1)   Wie groß Paul ist!
        how tall   Paul is
        'How tall Paul is!' *wh-exclamative*

(2)   Mann, ist Syntax einfach!
        boy   is syntax easy
        'Boy, is syntax easy!' *polar exclamative*

(3)   Dass die immer Turnschuhe anzieht!
        that she always sneakers   wears
        'That she always wears sneakers!' *that-exclamative*

All types of exclamatives share the illocutionary function exclamation. Exclamations are utterances that express an emotional attitude, e.g. surprise, shock or amazement at a certain state of affairs, thus they belong to the speech act *expressive*. The emotional attitude is often directed at the high degree to which something holds. With (1) for example the speaker expresses his surprise towards the fact that Paul is extremely tall and not only tall to a standard degree.

English *wh*-exclamatives are always SVO, i.e. they do not show subject-auxiliary inversion, whereas German *wh*-exclamatives can come with or without subject-auxiliary inversion.

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(4)   What shoes she wears!

(6)   *What shoes wears she!

(5)   Was für Schuhe die getragen hat!
       what for shoes   she wears
       'What shoes she wore!'

(7)   Was für Schuhe hat   die getragen!
       what for shoes   wears she
       'What shoes she wore!'

The main pitch accent typically falls either on the d-pronoun[2], which frequently occurs in excla-matives, or on the finite verb. Two puzzles arise with respect to sentence stress and verb position in German exclamatives[3]: (i) in V-final exclamatives main pitch accent is only accepted on the lexical verbs but not on the auxiliaries, see (8) vs. (9), and (ii) in V2-exclamatives main pitch accent is accepted on lexical verbs as well as auxiliaries, see (10) vs. (11).[4] I claim that the unusual sentence stress distribution is due to the factivity of exclamatives.

(8)   Wen die alles KENNT!
       who she all   knows
       'How many people she knows!'

(10)   Wen KENNT die alles!
       who knows   she all
       'How many people she knows!'

(9)   *Wen die alles getroffen HAT!
       who she all   met   has
       'How many people she met!'

(11)   Wen HAT die alles getroffen!
       who has she all   met
       'How many people she met!'

The propositional content of exclamatives is often claimed to be known by the speaker and the hearer. This property is also known as *factivity*. While some theories take factivity to be an essential property of exclamatives (Grimshaw 1979, Portner and Zanuttini 2003, Roguska 2008, Abels 2010), others assume factivity either only for a certain type of exclamatives (D'Avis 2013) or for a certain part[5] of exclamatives (Delsing 2010). Some theories even doubt the factivity status altogether (Rett 2011). In the following, I will show that most of the standard factivity tests either do not yield consistent results or are unapplicable to begin with. I will then argue that the two puzzles presented above provide new evidence for the factivity of exclamatives.

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[2]In addition to personal pronouns, German also has d(emonstrative)-pronouns. D-pronouns are different from personal pronouns in that they cannot be coreferent with a *discourse topic*, i.e. they can only be resolved to antecedents which are given but not maximally salient (see Bosch and Umbach 2008, Hinterwimmer 2014).

[3]The stress pattern is consistent across different types of exclamatives. I will demonstrate the pattern on *wh*-exclamatives since it is the only exclamative type that can be V2 as well as V-final, and thus is suitable to provide the most minimal pairs.

[4]The main pitch accent distribution of auxiliaries patterns with the main pitch accent distribution of copular verbs.

[5]In this case the high degree that exclamatives often express is not assumed to be part of the fact:

(i)   How unbelievably tall he is! FACT: He is tall.

2. Standard Factivity Tests

Standard factivity tests focus on the distinction between *asserted* propositions and *presupposed* propositions. With an assertion the speaker proposes to add a proposition to the common ground. In contrast, a presupposition is already part of the common ground when uttered. Tests that distinguish between assertions and presuppositions are *subsequent discourse moves, holes*, and *filters*. If exclamatives are factive, i.e. not assertive, then the next question that has to be answered is whether factivity is derived via a presupposition or via a conventional implicature. Since both types of inferences are very similar in their behaviour, some frameworks have subsumed the former under the latter (Karttunen and Peters 1979, Gazdar 1979, Chierchia and McConnell-Ginet 1990, Simons et al. 2010), and thus consider presuppositions as special cases of conventional implicatures, i.e. the ones that make propositions true. Accounts that argue for a difference between conventional implicatures and presuppositions (Stalnaker 1974, Karttunen 1974, Heim 1990, Potts 2005, Horn 2007) propose that difference to be anchored, again, in their relation to the common ground: conventional implicatures are added to the common ground as secondary assertions when uttered whereas presuppositions are already entailed by the common ground when uttered. Two tests can be used to figure out whether the hypothesized factivity of exclamatives is derived via conventional implicature or via a presupposition: *plugs* and *backgrounding*. For reasons of space, I will focus on *subsequent discourse moves* and *backgrounding*.[6]

2.1. Subsequent Discourse Moves

Previous research has examined subsequent (Rett 2011, Chernilovskaya et al. 2012, D'Avis 2013) as well as preceding (Castroviejo Miró 2008) discourse moves. If exclamatives are not factive, we would expect them to behave like assertions in discourse, i.e. the addressees should be able to question, confirm, or deny them. The dialogue in (12) provides an example for questioning while (13) additionally shows confirmation and denial.

(12)   A: How many people took part in the rally!
        B: Well, most of the people were just bystanders.   (Chernilovskaya et al. 2012: 115)

(13)   A: Hat der aber ein tolles Auto!
              has he aber a   great car
              'Boy, does he have a great car!'

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[6] Abels (2010) shows that the projection behavior of exclamatives with respect to filters and holes provides convincing evidence for a factivity presupposition. However, Abels has to rely on the premise that the factivity presupposition that comes with embedded exclamatives is the same as the one that comes with matrix exclamatives. He has to assume that exclamatives can be embedded – an idea that is highly problematic especially with respect to the embedding behaviour of English *wh*-exclamatives (see Rett 2011).

B: Findest du? / Finde ich nicht. / Finde ich auch. / Ja, das stimmt.
          think   you / think I   not   / think I   too   / yes that is.true
          'You think? / I don't think so. / I think so, too. / Yeah, that's right.' (D'Avis 2013: 194)

These tests are unreliable, however, because there are other examples that seem to show that exclamatives cannot be questioned, confirmed, or denied by the addressee, see (14) for denial and (15) for confirmation and questioning as well as denial. Hence, subsequent discourse moves do not provide a consistent test for factivity.[7]

(14)   A: (My,) What delicious desserts John bakes!
         B: ?? No (he doesn't), these are store-bought. John's actually a terrible cook.
                                                                                        (Rett 2011: 414)

(15)   A: Dass die den geheiratet hat!
               that   she him married   has
               'That she has married him!'
         B: #Findest du? / #Das finde ich auch.
               think   you / that   think I   too
               'You think? / I don't think so.'   (D'Avis 2013: 195)

Furthermore, these tests are highly problematic if one takes into consideration that presuppositions can be *accommodated* (Karttunen 1974). The discourse moves following an exclamative are appropriate reactions in case the propositional content is asserted as well as in case it is accommodated as a presupposition. Either the speaker asserts the propositional content and, therefore, expects the hearer to update the CG accordingly, or he presupposes it and, therefore, relies on the hearer's willingness to accommodate the presupposition into the CG. Subsequent discourse moves do not tell us whether the speaker chose the first or the second option. Similar presupposition tests such as the *Wait a minute* test (von Fintel 2004) are notoriously unreliable (Potts 2012).

2.2. Backgrounding

A possible way to distinguish conventional implicatures and presuppositions is by taking backgrounding into account. While all types of presuppositions can contain information that has been previously uttered, at least one type of conventional implicatures, i.e. *supplements*, has to contain information that is entirely new. They then quietly impose this new information on the common ground. The parenthetical *a cancer survivor* in (16-a) triggers the conventional implicature *Lance*

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[7]The differences between (12)-(13) and (14)-(15) require more attention. Due to space, however, this paper will not focus on this matter.

Armstrong is a cancer survivor while the factive verb *know* in (16-b) triggers the presupposition *Lance Armstrong is a cancer survivor*, only the latter is appropriate since the information is already part of the common ground.

(16)   Lance Armstrong survived cancer.

    a.   #When reporters interview Lance, a cancer survivor, he often talks about the disease.

    b.   And most riders know that Lance Armstrong is a cancer survivor.   (Potts 2005: 34)

Importantly, exclamatives pattern with presuppositions, see (17). The exclamative expresses information that was already introduced in the preceding clause.

(17)   I didn't expect us to have such a nice day at the park.
        What fun we had!

This intuition is shared cross-linguistically, see (18) for German and (19) for French. Both exclamatives, *Oh my god, was I happy!* as well as *How beautiful she is!* can contain information that is already part of the background.

(18)   Dann habe ich mich   furchtbar über den Lottogewinn gefreut. Mein Gott, habe ich
        then have I   myself extremely about the lottery.win   be.happy my   god have I
        mich   gefreut! Ich hab mich   vielleicht gefreut!
        myself be.happy I   have myself vielleicht be.happy
        'Then I was extremely happy about the lottery win. Oh my god, was I happy! I was so
        happy!'   (Altmann 1993: 33)

(19)   Comme elle est belle, comme elle est belle!
        'How beautiful she is, how beautiful she is!'   (Beyssade 2009: 32)

Whether or not information can be backgrounded depends on its relation to the common ground. Presuppositions are entailed by the common ground. This makes them capable of containing information that is already in the common ground. Conventional implicatures enter the common ground at the moment they are uttered; thus they usually give rise to redundancy violations in case the information is already part of the common ground.

However, when it comes to expressives, e.g. *damn* in (20), we have to admit that their ability to repeat is, according to Potts (2007), a rather defining criterion because the repetition intensifies the expressive attitude and hence does not lead to redundancy.

(20)   Damn, I left my damn keys in the damn car.   (Potts 2007: 182)

Since exclamatives are closely connected to the concept of expressives, we can attribute their ability to pick up previously uttered information not to their presuppositional status but rather to them being expressive.[8]

3. VERUM **Focus: New Evidence for Factivity**

Most of the presuppositions tests we have looked at so far were more or less inconclusive. Another way to determine the relation of an utterance to the common ground is by looking at its information structural properties, e.g. focus. In languages like German and English, focus is realized via pitch accents. Recall the puzzle introduced in (8) to (11) in which German exclamatives show a very unexpected accent distribution with respect to auxiliaries and their positions in the clause. In verb-final exclamatives an accent on an auxiliary is not acceptable whereas an accent on a lexical verb is fine. In contrast, V2-exclamatives allow accent on lexical verbs as well as on auxiliaries. That the acceptance might not only be due to the V2-position but to the C head in general is suggested by (21) and (22) .

(21)   a. *$[_{CP}$ $[_C$ Dass] $[_{TP}$ der mich angelogen HAT!]]
                    that   he me   lied   has
         b. $[_{CP}$ $[_C$ DASS] $[_{TP}$ der mich angelogen hat!]]
                    that   he me   lied   has
              'That he lied to me!'

(22) $[_{CP}$ $[_C$ HAT] $[_{TP}$ die viele Leute kennengelernt!]]
                  has   she many people got.to.know
          'Boy, did she get to know many people!'

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[8]Schlenker (2007: 240) criticizes the repeatability feature of expressives since it can result in different truth values: while (20) indicates that the speaker has a negative attitude towards his car and his keys, (i) only indicates the latter but not the former.

(i)   Damn, I left my damn keys in the car.

Judgements are far from clear. If there is a truth-conditional difference between (20) and (i) then (ii) is probably very unlikely to be uttered out of the blue. Porsche owners usually have a positive attitude towards their cars. If every occurrence of *damn* comes with a negative attitude towards the constituent it modifies, then one would expect for (ii) to be felicitous additional context is necessary, e.g. the owner mentioning that, lately, he is not happy with his Porsche anymore.

(ii)   Damn, I left my damn keys in the damn Porsche.

3.1. Focus in Alternative Semantics

Following Rooth (1992), I assume that focus indicates the presence of alternatives in the context. The basic idea of alternative semantics lies in the assumption of a *focus* semantic value which every syntactic object possesses in addition to its *ordinary* semantic value. For syntactic objects to be alternatives to each other, they both have to be elements of the focus semantic value they share, and they have to be different from each other with respect to their ordinary semantic value. To capture these ideas, Rooth (1992: 86) defines the *squiggle operator* $\sim$ that introduces a free variable that is restricted in the sense described above. This free variable needs to find an antecedent in the discourse in order for focus to be licensed. The restrictions are formulated in the *Focus Interpretation Principle* (FIP).

(23)   FIP (for contrastive alternative sets containing individuals):
        If a phrase α is construed as in contrast with a phrase β, then
        a. $[\![\beta]\!]^o \in [\![\alpha]\!]^f$ and
        b. $[\![\beta]\!]^o \neq [\![\alpha]\!]^o$
        and β is matching α in type.   (adapted from Rooth 1992: 86)

3.2. VERUM Focus and its licensing Conditions

VERUM *focus* (or *polar focus* as it is termed cross-linguistically) is a type of focus that emphasizes the truth of a proposition (Höhle 1992), which is thus called the VERUM *effect*. As such VERUM focus usually occurs in contexts in which the truth of the proposition is either undecided or explicitly denied. The former I call an *uncertainty* context the latter a *denial* context. (24) gives an example of an uncertatinty context, (25) for a denial context. In German, VERUM focus is realized as focus on the C head whereas English uses the insertion of emphatic *do*.

(24)   A: Ich frage   mich, ob Paul ein Drehbuch schreibt.
              I   wonder myself if   Paul a   screenplay writes
              'I wonder if Paul writes screenplays.'
        B: Ja, er SCHREIBT ein Drehbuch.
              yes he writes   a   screenplay
              'Yes, he DOES write screenplays.'

(25)   A: Sue hat ihren Mann   nicht verlassen.
              Sue has her   husband not   left
              'Sue didn't leave her husband.'

B: Doch, sie HAT ihren Mann   verlassen
doch she has   her   husband left
'You're wrong – she DID leave her husband.'

3.3. VERUM Focus as Focus on the Illocution

For languages like German, it can be argued that the VERUM effect is caused by the focus on either
a covert VERUM operator (Höhle 1992) or the sentence/illocutionary type operator itself (Büring
2006, Stommel 2011, Lohnstein 2012). The second option is supported by the observation that
the VERUM effect can only occur if the C head is focussed and C is typically thought to host this
operator.

(26)   A: I wonder if Paul writes books.
        B: #Ich denke, [$_{CP}$ [$_C$ dass] [$_{TP}$ er Bücher SCHREIBT]]
             I   think   that   he books   writes
             'I think, he WRITES books.'
        B': Ich denke, [$_{CP}$ [$_C$ DASS] [$_{TP}$ er Bücher schreibt]]
             I   think   that   he writes   books
             'I think he DOES write books.'
        B": Ja, [$_{CP}$ er [$_C$ SCHREIBT] [$_{TP}$ Bücher]]
             yes   he   writes   books
             'Yes, he DOES write books.'

The argument is based on the observation that assertions can be paraphrased in a way that the truth
value or the discourse function is included in the utterance. The focus then merely focuses what is
already part of the assertion, thus causing the VERUM effect.

(27)   Paul writes books.
        ⤳ *It is true* that Paul writes books (covert VERUM operator)
        ⤳ *I want to add to the common ground* that Paul writes books (illocution type operator)

For non-assertive speech acts like exclamations, it seems rather counterintuitive to argue for a
covert VERUM operator. It is more likely that VERUM focus in C focuses an illocutionary operator.
Since exclamatives do not function as assertions, focus on the C head should not give rise to the
VERUM effect, compare (30) to (31).

(28)   Paul hat viele Leute getroffen.
Paul has many people met
'Paul has met many people.'
... but I am not sure about that.

(29)   Paul HAT viele Leute getroffen.
Paul has many people met
'Paul DID meet many people.'
... but I am not sure about that.

(30)   Wen hat Paul alles getroffen!
who has Paul all met
'How many people Paul met!'
... but I am not sure about that.

(31)   Wen HAT Paul alles getroffen!
who has Paul all met
'How many people Paul met!'
... but I am not sure about that.

The exclamative focus in C does not result in a VERUM effect because exclamatives are not about adding a true proposition to the common ground. The focus on the illocution in C explains why there is no difference in acceptability of focus marking between auxiliaries and copulars on the hand and lexical verbs on the other. For the focus on the illocution, it does not matter what C is filled with, even complementizers can serve as a host.

(32)   a.   In wie vielen Ländern IST der schon gewesen!
in how many countries is he already been
'How many countries he DID travel to!'
       b.   Wie viele Seiten HAT die pro Tag geschrieben!
how man pages has she per day written
'How man pages she wrote daily!'
       c.   Wie viele Seiten SCHREIBT die pro Tag!
how many pages writes she per day
'How many pages she writes daily!'

Note, that it is still an open question what kind of focus alternatives one could assume for an illocutionary operator. One idea could be the relevant illocutions of the other participants in the discourse (see Lohnstein 2012). However, this idea is rather difficult to implement since alternatives have to be distinguished with respect to different addressees. More work needs to be done here in order to provide a complete picture of the VERUM focus distribution.

An alternative route is suggested by recent observations concerning the default stress pattern of *wh*-exclamatives in German. According to Repp (2015), speakers place main pitch accent in V2 *wh*-exclamatives either on an auxiliary in V2-position (see also Altmann 1993) or on the d-pronoun which frequently occurs in German exclamatives. This suggests that the stress pattern in (31) merely reflects the default sentence stress pattern in German V2-exclamatives independent of information structure.

3.4. VERUM Focus as Polar Focus

In order to use VERUM focus as a new test for factivity, we have to show that VERUM focus in V-final position is in fact possible. Under the assumption of an illocutionary type operator located in C, narrow focus on the verb-final position is predicted not to cause a VERUM effect in assertions. However, already Höhle (1992: 129) has observed that there are embedded sentences in which at least the focus on an auxiliary or a copular verb leads to a VERUM effect, see (33) and (34). In contrast, the focus on the lexical verb leads to standard narrow verb focus, see (35).

(33)   A: I wonder if Paul wrote a book.
           B: Ich denke, dass Paul ein Buch geschrieben HAT.
                I   think   that   Paul   a   book   written   has
                'I think that Paul DID write a book.'

(34)   A: I wonder if Paul is in Rome.
           B: Ich denke, dass Paul in Rom   IST.
                I   think   that   Paul   in   Rome   is
                'I think that Paul IS in Rome.'

(35)   A: I wonder if Paul writes books.
           B: #Ich denke, dass Paul Bücher SCHREIBT.
                I   think   that   Paul   books   writes
                'I think that Paul WRITES books.'

Lohnstein (2012) argues that VERUM focus in V-final position is only a side effect of the lack of lexical alternatives to the focussed verb. The poorer the lexical semantics of the verb, the fewer alternatives there are to produce contrast, the extreme case being copular verbs and auxiliaries for which the only alternative that is available is the verb's negation. If there are no alternatives to begin with except the negated version of the verb itself than the VERUM interpretation follows automatically. Lohnstein has to include negated versions into the focus semantic value in order for his argument to hold. If we follow this line of thought, we can potentially include tense alternatives as well. But this means that auxiliaries and copulars in fact do have alternatives other than their negation.

In order to avoid these problems, I would like to argue that the reason for the VERUM effect with auxiliaries and copulars and but not with lexical verbs lies in the general semantics of the syntactic objects. Copulars as well as auxiliaries are said to not contribute to the meaning to a proposition. This effect is traditionally derived via the identity function.

Since the identity function takes a semantic object and delivers the same semantic object, the only

alternative that these items can have is the negation of that semantic object. The focus semantic values for copular verbs shown in (36-a). A similar suggestion can be made for auxiliaries. They take a proposition and deliver a proposition; the focus semantic value is given in (36-b).

(36) a. $[\![[\mathrm{ist}_{COP}]_F]\!]^f = \{\lambda P[\lambda w[P(w)]], \lambda P[\lambda w[\neg P(w)]]\}$
      b. $[\![[\mathrm{hat}]_F]\!]^f = \{\lambda p[\lambda w[p(w)]], \lambda p[\lambda w[\neg p(w)]]\}$

The focus semantic values of copulars and auxiliaries reflect the intuition that the whole proposition is given and that only the polarity is focussed.

Now, let us see how (36) derives the focus alternatives for F-marked auxiliaries and copulars.[9]

(37) $[\![\text{dass Paul in Rom } [\mathrm{IST}]_F]\!]^f$ 'that Paul IS in Rome'
      $= \{\lambda w[\text{Paul is in Rome in } w], \lambda w\neg[\text{Paul is in Rome in } w]\}$
      $= \left\{ \begin{array}{l} \text{it is true that Paul is in Rome,} \\ \text{it is false that Paul is in Rome} \end{array} \right\}$

(38) $[\![\text{dass Paul ein Buch geschrieben } [\mathrm{HAT}]_F]\!]^f$ 'that Paul DID write a book'
      $= \{\lambda w[\text{Paul wrote a book in } w], \lambda w\neg[\text{Paul wrote a book in } w]\}$
      $= \left\{ \begin{array}{l} \text{it is true that Paul wrote a book,} \\ \text{it is false that Paul wrote a book} \end{array} \right\}$

The focus semantic value of an utterance with an F-mark on a lexical verb with rich lexical semantics is given in (39) for comparison.

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[9]Note, that the complementizer *dass* is equally poor in terms of lexical alternatives. If the F-marker in (38) is shifted to the complementizer, the focus alternatives do not change.

(i) Ich denke, $[\![[\mathrm{DASS}]_F \text{ Paul ein Buch geschrieben hat}]\!]^f =$
     $\left\{ \begin{array}{l} \text{it is true that Paul wrote a book,} \\ \text{it is false that Paul wrote a book} \end{array} \right\}$

One could argue that the complementizer denotes an identity function as well since it does not contribute to the overall meaning of the sentence. The focus semantic value is given below:

(ii) $[\![[\mathrm{dass}]_F]\!]^f = \{\lambda p[\lambda w[p(w)]], \lambda p[\lambda w[\neg p(w)]]\}$

This point is not crucial for the VERUM focus distribution in exclamatives but it provides a complete picture for VERUM effects in German embedded sentences in general. The main argument that is put forward against VERUM focus as illocution focus is based on the occurrence of VERUM effects in embedded sentences where there is most likely no such operator present. If we can derive VERUM effects in embedded sentences solely via contrastive alternatives of the identity function than we can avoid assuming an illocutionary operator for these sentences.

(39) $[\![$dass Paul Bücher [SCHREIBT]$_F]\!]^f$ 'that Paul WRITES books'

$$= \{\lambda w.\ f(Paul)\ in\ w \mid f \in D_{\langle e,st \rangle}\}= \left\{ \begin{array}{c} \text{that Paul writes books,} \\ \text{that Paul corrects books,} \\ \text{that Paul reads books,} \\ ... \end{array} \right\}$$

Following the FIP (Rooth 1992), focus is licensed if the free variable, which is introduced by the squiggle operator, finds an antecedent in the discourse that (i) is an element of the focus semantic value of the F-marked phrase and (ii) is different from the ordinary semantic value of the F-marked phrase. Thus, VERUM focus is licensed if the polar alternative can be found as an antecedent in the discourse. This is obviously the case in denial contexts where the negative alternative is explicitly mentioned, as in (25). But it is also implicitly given in contexts where the truth of a proposition is still undecided, as in (24). The VERUM effect is the result of the established contrast to the negative alternative in the discourse. In contrast, focus on a lexical verb should not be licensed because it does not create polar alternatives in the first place. Let us see how this works out in detail.

3.4.1. Denial Contexts

A denial context with focus on a lexical verb is given in (40). The squiggle operator which marks the focus domain applies at the sentence level.

(40)   A: [Paul schreibt keine Bücher.]$_3$
             Paul writes   no   books
             'Paul does not write books.'
         B: #Doch, ich denke, [dass er Bücher [SCHREIBT]$_F$] $\sim$ v$_3$
             doch I   think   that he books   writes
             'I think he WRITES books.'

The second constraint of the FIP is satisfied because the meaning of the antecedent is different from the meaning of the clause containing the F-marked phrase.

(41) $[\![$Paul schreibt keine Bücher$]\!]^o \neq [\![$dass Paul Bücher [SCHREIBT]$_F]\!]^o$
         $=\lambda w.\neg[$Paul writes books in w$] \neq \lambda w.$Paul writes books in w

However, the first constraint is not satisfied, see (42).

(42) $[\![$dass Paul Bücher [SCHREIBT]$_F]\!]^f=$

$$\{\lambda w.\ f(Paul)\ in\ w\ |\ f \in D_{\langle e,st \rangle}\} = \left\{ \begin{array}{c} \text{that Paul writes books,} \\ \text{that Paul corrects books,} \\ \text{that Paul reads books,} \\ ... \end{array} \right\}$$

$$[\![\text{Paul schreibt keine Bücher}]\!]^o \notin [\![\text{dass Paul Bücher [SCHREIBT]}_F]\!]^f$$

Since the first constraint of the FIP is violated, focus on a lexical verb is not licensed in (40).

A denial context with focus on an auxiliary is given in (43).

(43)   A: [Paul hat kein Buch geschrieben.]$_3$
              Paul has no   book written
              'Paul did not write a book.'
        B: Doch, ich denke, [dass er ein Buch geschrieben [HAT]$_F$] $\sim$ v$_3$
              doch I   think that he a   book written   has
              'I think he DID write a book.'

The first as well as the second constraint of the FIP are satisfied. Thus, focus on the auxiliary in (43) is licensed.

(44) $[\![\text{Paul hat kein Buch geschrieben}]\!]^o \neq [\![\text{dass Paul ein Buch geschrieben [HAT]}_F]\!]^o$
        $= \lambda w.\neg[\text{Paul wrote a book in w}] \neq \lambda w.\text{Paul wrote a book in w}$

(45) $[\![\text{dass Paul ein Buch geschrieben [HAT]}_F]\!]^f$
        $= \{\lambda w[\text{Paul wrote a book in w}], \lambda w\neg[\text{Paul wrote a book in w}]\}$
        $= \left\{ \begin{array}{l} \text{it is true that Paul wrote a book,} \\ \text{it is false that Paul wrote a book} \end{array} \right\}$
        $[\![\text{Paul hat kein Buch geschrieben}]\!]^o \in [\![\text{dass Paul ein Buch geschrieben [HAT]}_F]\!]^f$

3.4.2. Uncertainty Contexts

An uncertainty context with focus on a lexical verb is given in (46).

(46)   A: Ich frage mich, ob Paul Bücher schreibt.
        'I wonder if Paul writes books.'
        B: #Ja, ich denke, dass er Bücher SCHREIBT.
        'I think he WRITES books.'

The embedded interrogative clause denotes a set of the form $\{p, \neg p\}$, viz. $\{\lambda w[\text{Paul writes a b. in } w], \lambda w \neg[\text{Paul writes a b. in } w]\}$. Only the second element in the set serves as an antecedent for the free variable that is introduced by the squiggle. Thus, the antecedent is implicitly given, shown in (47).

(47)   A: Ich frage mich, $\{p, [\neg p]_3\}$
        B: #Ja, ich denke, [dass er Bücher [SCHREIBT]$_F$] $\sim v_3$

Under the assumption that we can identify implicit antecedents with Rooth (1992), we get the same antecedent as in the denial contexts above: $\lambda w \neg[\text{Paul writes books in } w]$. Consequently, the second constraint of the FIP is satisfied, see (41) above, but not the first constraint, see (42) above.

Focus on an auxiliary is given in (48), with the focus domain shown in (49).

(48)   A: Ich frage mich,   ob Paul ein Buch geschrieben hat.
             I   ask   myself if Paul a   book written   has
             'I wonder if Paul wrote a book.'
        B: Ja, ich denke, dass er ein Buch geschrieben HAT.
             yes I   think   that he a   book written   has
             'I think he DID write a book.'

(49)   A: Ich frage mich, $\{p, [\neg p]_3\}$
        B: Ja, ich denke, [dass er ein Buch geschrieben [HAT]$_F$] $\sim v_3$

Again, the antecedent $\lambda w \neg[\text{Paul writes books in } w]$ satisfies both constraints of the FIP, identical to the denial contexts above, see (44) and (45). Hence, focus is licensed in (48).

3.4.3. VERUM Focus in Factive Complements and Exclamatives

With the focus semantic values proposed in (36) we can explain why auxiliaries and copulars but not lexical verbs can carry VERUM focus in embedded clauses. Up until now, we have looked at clauses that are embedded under non-factive verbs. Factive verbs should change the predictions for the distribution of VERUM focus since they presuppose the truth of their complement. In an uncertainty context factive complements should not license VERUM focus because the factivity presupposition already makes sure that the proposition is true. Since the truth of the propositional content is already entailed by the common ground at the moment of utterance, factive complements will not be able to find their antecedent, i.e. the negative alternative, in the discourse. They will only find the positive alternative: $\lambda p \lambda w[p(w)]$ which satisfies the first constraint of the FIP but,

crucially, not the second constraint since the positive alternative is not different from the ordinary semantic value of the factive complement. As is shown in (50), the auxiliary cannot be focussed in factive complements if they are preceded by an uncertainty context (see also Stommel 2011: 108).

(50)   A: I wonder if it's Peter's birthday today.
        B: #Ja   stimmt, mensch, ich hab' doch tatsächlich vergessen, dass er heute Geburtstag
             yes true   gosh   I   have doch indeed   forgotten that he today birthday
             HAT.
             has
             'Right, gosh, I completely forgot that it IS his birthday today.'

The only possible occurrence of VERUM focus in factive complements is a denial context – a context in which the speaker wants to substitute the negative alternative with the positive one. This is a case of correction focus, i.e. CG revision[10] (Steube 2001, Umbach 2004, Karagjosova 2006).

(51)   A: Hanna likes company when she visits the opera, which is why she is angry about the
             fact that her daughter did not go with her this time.
        B: You're wrong – Hanna likes it most when she goes alone.
             Sie ärgert   sich   darüber, dass ihre Tochter   gestern   mit ihr in der Oper
             she is.angry herself about   that her daughter yesterday with her in the opera
             WAR.
             was
             'She is angry that her daughter DID accompany her.'

Under the assumption that exclamatives are factive, we can now make the prediction that they pattern with factive complements, i.e. they can only license narrow focus on auxiliaries and copulars in V-final exclamatives if they occur in denial contexts.

(52)   A: Were you surprised that you didn't get the job?
        B: Nein, dass ich ihn bekommen HABE! Darüber war ich überrascht.
             no   that I it   gotten   have   about was I surprised
             'No, that I DID get the job! I was surprised about that.'

(53)   A: Peter is not a big traveller. The places he has not been to!

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[10]Following Karagjosova (2006), denial contexts are analyzed as negotiations of the CG. Therefore, the CG in (51) does not entail $\neg p$ but rather *A believes* $\neg p$ as a discourse commitment of A (see Gunlogson 2003). The factivity presupposition of speaker B's utterance cannot exclude $\neg p$ from the CG since $\neg p \notin CG_{A,B}$. However, $\neg p$ can still act as an antecedent for VERUM FOCUS to be licensed. This is different to uncertainty contexts like the one in (50) in which a factive presupposition can directly exclude $\neg p$-*worlds* from the common ground (CG:$\{p, \neg p\}$).

B: Aber wo   der auch schon   gewesen IST!
          but   where he also already been   is
          'But the places he HAS been to already!'
          Just think about the time before he started studying.

Uncertainty contexts like those in (54) and (55) do not license VERUM focus because the factivity of the exclamatives prevents the propositions to find their negative alternative in the context.

(54)   A: How did her interview go? Do you know if she got the job?
        B: You know I was completely surprised.
           #Dass die den Job bekommen HAT!
            that she the job gotten   has
            'That she DID get the job!'

(55)   A: I'm not an expert on traveling. But ask Peter, maybe he has been to many of the places that you want to know about.
        B: Yes, I already talked to him and I was pretty surprised.
           #Wo   der schon   gewesen IST!
            where he already been   is
            'The places he HAS been to already!'

Both uncertainty and denial contexts license V-final narrow focus on auxiliaries and copulars if they are embedded under non-factive predicates. In factive complements as well as in root-exclamatives V-final narrow focus on auxiliaries and copulars is only licensed by denial contexts. The only reasonable explanation that captures this VERUM focus distribution is to assume that auxiliaries and copulars denote the identity function whose only focus alternative is its negation. The negative alternative can be found in uncertainty as well as in denial contexts if the clause is embedded under a non-factive predicate. However, factive complement clauses are not licensed in uncertainty contexts because the factivity presupposition already makes sure that the proposition is true so that the negative alternative cannot be found in the discourse as an antecedent. If the negative alternative is explicitly present, as it is the case in the denial context, then VERUM focus can be used as correction focus by which the speaker signals that he wants to substitute the negative alternative with the positive one and thus revises the common ground. Exclamatives behave exactly like factive complements; therefore they have to be factive.

4. Conclusion

The distribution of VERUM focus provides a novel test for factivity – one that is, crucially, also applicable to exclamatives. It gives consistent results, unlike other presupposition test such as subsequent discourse moves discussed above. Furthermore, it does not have to rely on the premise

that the factivity presupposition that comes with embedded exclamatives is the same as the one that comes with matrix exclamatives which is what Abels (2010) has to assume in order to apply plugs and filters as relevant presupposition tests. Since V-final exclamatives can also be used as matrix exclamatives, VERUM focus can be tested independent of embedding, see e.g. (53)-(55). A final advantage of the VERUM focus test is that it gives an explanation for what otherwise would be a completely mysterious verb stress pattern in German exclamatives.

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E-Type Readings of Quantifiers under Ellipsis[1]

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Abstract. It is observed that quantifiers in ellipsis antecedents systematically give rise to two different readings in the ellipsis site, which we call *Q-* and *E-type readings*. Contrary to previous studies, we show that both readings are attested under both sluicing and VP ellipsis, although their availability is constrained by independent discourse requirements. Our findings have theoretical consequences for ellipsis licensing, in particular, for the *identity condition* on ellipsis. Focusing here on sluicing, we put forward a dynamic semantic formulation of the identity condition in terms of mutual dynamic entailment, which we call *d-*GIVEN*ness*.

Keywords: E-type anaphora, quantification, VP ellipsis, sluicing, dynamic semantics

1. Introduction

Elliptical phenomena in natural languages are observed with a number of different syntactic categories (e.g. VP ellipsis vs. sluicing) and sometimes come with idiosyncratic syntactic restrictions (e.g. gapping), but one common feature is that elided phrases must be 'sufficiently similar' to some antecedent phrase in the discourse.[2] This condition is called the *identity condition* on ellipsis. The strictest formulation of the identity condition demands the antecedent phrase, XP_A, and the elliptical phrase XP_E, to be identical in all respects (naturally excluding phonological content). However, there is ample evidence that this strict formulation is untenable. For example, phenomena discussed under the rubric of *vehicle change* show that XP_A and XP_E may differ in certain formal features (Fiengo and May, 1994). Concretely, VP_A and VP_E in the following example differ in the gender feature on the pronoun, but the VP ellipsis is licensed.

(1)   John [$_{VP}$ submitted his paper to LI], but Mary didn't [$_{VP}$ ~~submit her paper to LI~~].

See also Kehler (2002) and Merchant (2013) for cases involving voice mismatches and NP-antecedents for VP ellipsis, which also show that XP_A and XP_E need not be completely identical.

In the present paper, we discuss instances of sluicing and VP-ellipsis where XP_A contains a quantificational noun phrase (QNP). We observe that in such situations, XP_E systematically gives rise to two interpretations. One interpretation, which we call the *Q-reading*, is the reading that is expected under total identity of XP_A and XP_E. The other reading, on the other hand, involves a

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[2]Throughout this paper, we speak of elided phrases, adopting the idea that elliptical phrases are phonologically elided but syntactically and semantically active. However, nothing crucial in our analysis hinges on this assumption.

definite phrase in XP_E in place of the QNP, that is anaphoric to the QNP in XP_A. We call this reading the *E-type reading*.

The E-type reading is of particular interest here, as it constitutes additional evidence that the notion of similarity between XP_A and XP_E relevant for ellipsis licensing cannot not be total identity, and must allow a certain degree of difference. In particular, the licensing needs to refer to the anaphoric dependency between the QNP in XP_A and the anaphoric term in XP_E. In order to capture this, we put forward a semantic formulation of the identity condition in terms of mutual dynamic entailment, or *d*-GIVENNESS. We take this to be showing that ellipsis licensing cannot be entirely syntactic, and must refer to the semantics of XP_A and XP_E, following, e.g. Rooth (1992b) and Merchant (2001) in spirit if not implementation.

The present paper is structured as follows. In Section 2, we show that both Q- and E-type readings are available both under sluicing and under VP ellipsis, contrary to previous studies. We also point out that the availability of the E-type reading is subject to independent discourse restrictions. After critically discussing previous analyses of the E-type reading of sluicing in Section 3, we will propose our identity condition using the notion of mutual dynamic entailment between XP_A and XP_E (*d*-GIVENNESS) in Section 4.

2. The Data

In this section we show that the ambiguity between the Q- and E-type readings is observed with both sluicing and VP ellipsis. This is contrary to Romero (2003) and Chung et al. (2011), who claim that the E-type reading is obligatory for sluicing and the Q-reading is obligatory for VP ellipsis. We show that there are independent discourse restrictions on the availability of the E-type reading, and when they are properly controlled for, both readings can be observed with both types of ellipsis.

2.1. Sluicing

Let us first convince ourselves that quantifiers under sluicing may give rise to E-type readings. In the following example, the relevant quantifier in the antecedent clause TP_A is an indefinite *a mathematical theorem*, which most naturally gives rise to an anaphoric reading in the ellipsis site. Here and below, we represent the E-type reading with a definite description, but we do not (yet) make commitments about what exactly is elided.[3]

(2) If John asks me how [$_{TP_A}$ a mathematical theorem was proved],

a. #I will also tell him by whom [$_{TP_E}$ ~~a mathematical theorem was proved~~].   Q-reading

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[3]In the final analysis (§4), we crucially assume that the elided definite has descriptive content.

    b. I will also tell him by whom [$_{TP_E}$ ~~the mathematical theorem was proved~~].

                                              E-type reading

It becomes especially clear that the felicitous reading corresponds to the E-type reading when we consider overt continuations corresponding to the two potentially elided TPs in (2a) and (2b):

(3)   If John asks me how a mathematical theorem was proved,
        a. #I will also tell him by whom a mathematical theorem was proved.
        b. I will also tell him by whom the mathematical theorem was proved.

Since (2) is felicitous with sluicing, it must receive the E-type reading. This observation itself does not say anything about the availability of the Q-reading, however, as the Q-reading is simply pragmatically ruled out here.

The following examples show that the Q-reading is in principle available under sluicing. Here again, in order to see the difference between the two readings, it is useful to consider overt continuations corresponding to the putative ellipsis sites.

(4)   [$_{TP_A}$ John applied to five graduate schools].
        a. I don't know why [$_{TP_E}$ ~~John applied to five graduate schools~~].   Q-reading
        b. I don't know why [$_{TP_E}$ ~~John applied to the five graduate schools~~].   E-type reading

What is crucial here is that the remnant *wh*-phrase is *why*. In embedded *why*-questions, the Q- and E-type readings give rise to truth-conditionally distinct readings. According to the Q-reading, the relevant reason (that the speaker doesn't know) is why John applied to so many graduate schools. On the other hand, under the E-type reading, the relevant reason is why John chose those five schools, and not others. With sluicing (4) is ambiguous between these two readings, while without ellipsis, there is only one reading. Therefore, (4) with sluicing is ambiguous between the Q- and E-type readings.

It should be noted here that in the previous literature, most observations are based on data involving different types of *wh*-remnants, but with them, the distinction between the two readings is obscured. For instance, consider the following examples adapted from Chung et al. (2011: 43).

(5)   We know that [$_{TP_A}$ someone was reading],
        a. but we don't know to whom [$_{TP_E}$ ~~someone was reading~~].   Q-reading
        b. but we don't know to whom [$_{TP_E}$ ~~they were reading~~].   E-type reading

Although Chung et al. (2011: 43) remark that the most natural interpretation is about a single person, and so the elided clause does not seem to introduce a new discourse referent, we think that the distinction between the two reading is not as clear as Chung et al. seem to assume, given that the Q-reading of (5) without the ellipsis seems to be able to mean a very similar thing (perhaps under the specific reading of *someone*). In our example with *why* in (4), on the hand, the truth-conditional distinction between the readings is palpable, and it shows that the two readings are indeed both available, as explained above.

2.2. VP Ellipsis

Let us now turn to VP ellipsis. The following example with donkey anaphora shows that both interpretations are possible. As in the case of examples with sluicing, the interpretive distinction between the two readings is clear when the overt continuations corresponding to the putative ellipsis sites are considered.

(6)   Whenever Prof. Jones is [$_{VP_A}$ working on a paper],
   a. the postdocs cannot [$_{VP_E}$ ~~work on a paper~~].   Q-reading
   b. the postdocs cannot [$_{VP_E}$ ~~world on the paper~~].   E-type reading

Specifically, under the Q-reading, the postdocs cannot work on any paper whatsoever, when Prof. Jones is working on a paper. The E-type reading is weaker than this, meaning only that the postdocs cannot work on the paper that Prof. Jones is working on.

In order to reinforce our point here, we present a few more pieces of evidence that both interpretations are available with VP ellipsis. Firstly, in the following example, only the Q-reading is pragmatically felicitous. This is because, in an out-of-the-blue context, *John being anxious* explains why he would apply to *so many* graduate schools (Q-reading), whereas it does not provide a plausible explanation for why he would apply to a particular set of graduate schools. Crucially, the same contrast obtains without ellipsis.

(7)   John [$_{VP_A}$ applied to five graduate schools], because he was anxious.
   a. Why else would he [$_{VP_E}$ ~~apply to five graduate schools~~]?   Q-reading
   b. #Why else would he [$_{VP_E}$ ~~apply to the five graduate schools~~]?   E-type reading

On the other hand, in the following example, only the E-type reading is felicitous.

(8)   John [$_{VP_A}$ applied to five graduate schools], because they were high in the league tables.
   a. #Why else would he [$_{VP_E}$ ~~apply to five graduate schools~~]?

    b. Why else would he [$_{\text{VP}_E}$ ~~apply to the five graduate schools~~]?

In an out-of-the-blue context, that the graduate schools were high in the league table provides a plausible explanation for why John would apply to *them* (E-type reading), but it fails to provide a plausible explanation for why he would apply to *so many* graduate schools (Q-reading).

These two examples constitute strong evidence that the Q- and E-type readings are separate readings, and moreover that they are both available with VP ellipsis.

This conclusion is in direct conflict with what Romero (2003) and Chung et al. (2011) assume, namely that the E-type reading is unavailable with VP ellipsis. We note that in many canonical instances of VP ellipsis, such as (9), only the Q-reading is available. This is the residue that our analysis must explain.

(9)   John [$_{\text{VP}_A}$ read two novels], and
      a. Bill did [$_{\text{VP}_E}$ ~~read two novels~~], too.   Q-reading
      b. *Bill did [$_{\text{VP}_E}$ ~~read the two novels~~], too.   E-type reading

We claim in §2.3 the unavailability of the E-type reading in this example is due to independent restrictions on discourse coherence. In fact, the same restrictions apply to sluicing as well, as we will see below.

2.3. Coherence Relation

We claim that the crucial feature of examples like (9) that blocks the E-type reading is that they involve two sentences that stand in the *parallel relation*, in the sense that the sentences containing XP_A and XP_E are answering the same (implicit or explicit) question. In the case of (9), the most natural implicit question is *who read two novels?*. Then, for reasons of discourse coherence, the E-type reading is simply not available, because it would be infelicitous as an answer to this implicit question.

To be more precise, answers to a question are felicitous only if they satisfy the following condition (cf. Krifka 2001; Roberts 2012 among others). Here $\|\alpha\|$ is the focus semantic value of α in the sense of Rooth (1992a).

(10) **The Question-Answer Congruence Condition**:
        A declarative sentence A is *congruent* to a question Q iff $\|A\| = [\![Q]\!]$.

For concreteness, we assume a Hamblin-Karttunen semantics for questions, according to which they denote sets of possible answers. for example:

(11) $[\![\text{who read two books}]\!] = \{p \,|\, p = \lambda w.\exists x, X[\text{books}(X) \wedge |X| = 2 \wedge x \text{ read two books in } w]\}$

Intuitively, in order to derive the focus semantic value of a sentence, we replace each F-marked expression of type τ with a variable ranging over expressions of type τ, and take the set of propositions corresponding to every possible valuation of the variable. To derive the semantic value of a *wh*-question, we do the same thing, only rather than replacing F-marked expressions with variables, we reconstruct the *wh*-phrases to their base-positions and replace them with variables.

Under a Roothian focus semantics, the focus semantic value of *John$_F$ read two novels* is the same set as (11), so Question-Answer Congruence holds, and it can be given as a felicitous answer to (11). Similarly for *Bill$_F$ read two novels*. On the other hand, the focus semantic value of *Bill$_F$ read the two novels* is as follows:

(12) $\|\text{Bill}_F \text{ read the two novels}\| = \{p \,|\, p = \lambda w.\exists x[x \text{ read } \iota X[\text{novels}(X) \wedge |X| = 2] \text{ in } w]\}$

Note that the set of propositions denoted by (12) is a strict subset of the set of propositions denotes by (11). Consequently, the E-type reading of (9) would not comply with the Question-Answer Congruence Condition, and hence it would not be a felicitous answer to the implicit question. For this reason, the E-type reading of (9) is unavailable.

To further buttress this point, we observe that when the example (9) is manipulated so that the two sentences are no longer in a parallel relation, the E-type reading indeed becomes available. For example,

(13)   Right after John read two novels,
      a. Bill did ~~read two novels~~, too.   Q-reading
      b. Bill did ~~read the two novels~~, too.   E-type reading

Further support of this analysis comes from the observation that sluicing is subject to the same constraint (cf. Romero 2003). For example, the following example does not have the E-type reading, as the two sentences stand in a parallel relation.

(14)   (Do you know which students like most of the professors?)
      I know which BOYS like most of the professors.
      a. But I don't know which GIRLS ~~like most of the professors~~.   Q-reading
      b. *But I don't know which GIRLS ~~like the professors~~.   E-type reading

In sum, we have observed that both Q- and E-type readings are available under sluicing and VP ellipsis, contrary to Romero (2003) and Chung et al. (2011), although their availability is sometimes restricted due to independent discourse considerations.

3. Previous Analyses of the E-type readings of sluicing

The Q-reading is straightforward to account for under any theory of ellipsis, as what one needs to assume is total identity (modulo vehicle change). The E-type reading, on the other hand, is more problematic, as it seems that XP_A and XP_E need to mean different things. In fact, as far as we can see, many recent theories of sluicing such as AnderBois (2010, 2014) and Barker (2013) simply cannot account for the E-type reading (the details are suppressed here for reasons of space), and one can only find several previous analyses of the E-type reading under sluicing, but we claim now that they are all unsatisfactory.

Firstly, assuming the false generalisation that sluicing only allows the E-type reading and VP ellipsis only allows for the Q-reading, Romero (2003) and Chung et al. (2011) tailor-made their analyses to derive this generalisation. In light of the data in the previous section, their analyses are simply empirically inadequate.

Merchant (2001) (cf. Merchant 1999), on the other hand, recognizes the existence of both E-type and Q-readings with sluicing, illustrating this with examples such as (15).

(15) a. Exactly five officers were fired, but I don't know why
      b. =...why exactly five were fired.
      c. =...why exactly they$^{E\text{-}type}$ were fired.   (Merchant, 2001: p. 212)

Merchant argues at length that ellipsis is subject to the following focus condition.

(16) **Focus condition on ellipsis**
      A phrase XP can be deleted only if XP is e-GIVEN.

A phrase XP_E is e-GIVEN if its focus closure, F-clo(XP_E), and the focus closure of its antecedent, F-clo(XP_A), entail each other. F-clo(XP) is the result of replacing F-marked constituents of XP with existentially bound variables of the appropriate type.

Under the Q-reading, Merchant assumes that both TP_A and TP_E contain the relevant quantifier, which results in satisfaction of the focus condition. To see this more concretely, let us apply this analysis to (4). We assume a representation where the quantifiers have undergone QR.

$$\overbrace{}^{\text{TP}_A}$$

(17) a. [$_{TP}$ [five graduate schools] $\lambda 1$ [$_{TP}$ John applied to t_1]]

$$\overbrace{}^{\text{TP}_E}$$

b. but I don't know why [$_{TP}$ [five graduate schools] $\lambda 1$ [$_{TP}$ John applied to t_1]]

As TP_A and TP_E are totally identical, their F-closures entail each other and so TP_E is e-GIVEN. Consequently, TP_E can be elided.

Under the E-type reading, on the other hand, Merchant assumes that TP_A does not contain the quantifier, but only its trace, whereas TP_E contains a co-indexed E-type pronoun.

$$\overbrace{}^{\text{TP}_A}$$

(18) a. [$_{TP}$ [five graduate schools] $\lambda 1$ [$_{TP}$ John applied to t_1]]

$$\overbrace{}^{\text{TP}_E}$$

b. but I don't know why [$_{TP}$ John applied to them$_1^{\textit{E-type}}$]

As in Heim and Kratzer (1998) among others, Merchant assumes that pronouns are interpreted as variables. This makes TP_E in (18) e-GIVEN with respect to TP_A, provided that the trace in TP_E and the pronoun in TP_A are co-indexed.

In support of this analysis, Merchant observes that in cases where anaphoric pronouns are not licensed, the E-type reading is not available, even though TP_A and TP_E would satisfy the focus condition.

(19) No one helped, but I don't know why.
    a. =...why no one helped.
    b. $\neq$...*why they$^{\textit{E-type}}$ helped.   (Merchant, 2001: p. 213)

3.1. Scope Island in the Antecedent

In large part, we agree with Merchant's analysis. For example, we follow Merchant in claiming that under the E-type reading, there is an E-type pronoun in TP_E. We argue that the focus condition is too restrictive however, and rules out attested cases of E-type readings. A crucial piece of evidence for us is the availability of an E-type reading licensed by a quantifier in an embedded clause in TP_A.[4]

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[4](20) is in fact four-ways ambiguous (at least). There is both a Q- and an E-type reading corresponding to a 'short' parse of the ellipsis site, illustrated in (ia) and (ib) respectively.

(20)   John claimed that most students$_1$ in the room cheated,

       a.   but I don't know why ~~he claimed that most students in the room cheated~~.   Q-reading

       b.   but I don't know why ~~he claimed that they$_1$ cheated~~.   E-type reading

Recall that under the E-type reading, Merchant assumes that TP$_A$ does not contain the quantifier, but only its trace. Therefore the representation of TP$_A$ would have to involve QR of *most students* out of a scope island: the finite clause embedded under *claim*. This is independently ruled out.[5]

(21)   a. $*[_{TP}$ [most students in the room] $\lambda1$ $\overbrace{[_{TP} \text{John claimed } [_{CP} \text{ that } t_1 \text{ cheated}]]]}^{TP_A}$

       b.   but I don't know why $\overbrace{[_{TP} \text{John claimed } [_{CP} \text{ that they}_1^{E\text{-}type} \text{ cheated}]}^{TP_E}$

3.2. ∃-Type Shifting

An additional issue for Merchant's analysis is the inconsistent application of ∃-binding. Crucially, in deriving the E-type reading, Merchant assumes that the trace of the quantifier in TP$_A$ is not ∃-bound. Elsewhere, however, Merchant assumes that the trace of movement (specifically, of a moved wh-expression) is ∃-bound, in order to license sluicing with an indefinite correlate.

(22) $[_{TP_A}$ Someone left the room], but I don't know who$_1$ $[_{TP_E}$ ~~t_1 left the room~~].

(23)   F-clo(TP$_A$) = F-clo(TP$_E$) = $\exists x.x$ left the room

Merchant could claim that this is because of some distinction between *wh*-expressions on the one hand, and quantificational DPs on the other. Regardless of whether or not an account of this kind could be made to work, there is a problem. A *wh*-expression in the antecedent clause can license an E-type reading of the ellipsis site. If it were possible for the trace of the *wh*-expression in TP$_E$ to be ∃-bound, we predict unattested readings.

(i)   a.   but I don't know why ~~most students in the room cheated~~.

       b.   but I don't know why ~~they$_1$ cheated~~.

We put these other readings to one side in our discussion, as they are expected under Merchant's focus condition.

   [5]To see that this is the case, note that (i) lacks an inverse scope reading (**most students in the room* > *someone*).

(i)   Someone claimed that most students in the room cheated.

(24)   I know what John bought at the OUP bookstore,

    a. *but I don't know why ~~John bought something at the OUP bookstore~~.   Q-reading

    b. but I don't know why ~~John bought it at the OUP bookstore~~.   E-type reading

The unattested Q-reading can be derived via $\exists$-binding as follows.

(25)   a. TP_A = John bought t_{wh} at the OUP bookstore

    b. $\text{TP}_E = \exists x.$ John bought x at the OUP bookstore

    c. $\text{TP}_A = \exists x.$ John bought x at the OUP bookstore $\exists$-type shifting

    d. F-clo(25c) = F-clo(25b) = $\exists x.$ John bought x at the OUP bookstore

3.3. Anaphoric Dependency

Our final issue with Merchant's account is more conceptual. Merchant's account is framed in terms of a static semantics, with no substantive technology for dealing with cross-sentential anaphora. For the E-type reading to be available however, it is clearly necessary for the E-type pronoun in TP_E to be *anaphoric* on the quantifier in TP_A. According to Merchant's account, the E-type reading satisfies the focus condition just in case the trace of the quantifier in TP_A is *co-indexed* with the pronoun in TP_E. Since the trace of the quantifier comes to be λ-bound over the course of the derivation however, the index on the trace does not in any sense determine the discourse referent of the quantifier (in Heim's 1982 sense). Co-indexation therefore fails to guarantee that the pronoun in TP_E is anaphoric on the quantifier in TP_A. We believe that it is desirable for the identity condition on ellipsis to enforce the requirement that the pronoun in TP_A be anaphoric on the quantifier in TP_E.

4. Towards a Dynamic Account: d-GIVENNESS

In order to account for the E-type reading, we propose a dynamic semantic version of Merchant's focus condition, which requires XP_E and XP_A to *dynamically entail* each other in the sense to be made clear below. As we will see, by using dynamic semantics, we can formally capture the anaphoric dependency between the quantifier in XP_A and the definite phrase in XP_E.

4.1. File Change Semantics

We adopt *File Change Semantics* (FCS) (Heim, 1982) with some modifications. One of the central ingredients of FCS is files F, which are sets of pairs consisting of a possible world w and an

assignment a. Following Heim (1982), we assume that assignments are total functions from file cards (variables) to individuals.

Declaratives sentences denote *File Change Potentials* (FCPs), which are functions from files to files. We adopt Heim's $+$ notation here. Presuppositions put definedness conditions on $+$.

(26)   a. $F + [\![\text{it is raining}]\!] = \{\, \langle w, a \rangle \in F \mid \text{it is raining in } w \,\}$

        b. $F + [\![\text{it stopped raining}]\!]$ is defined only if for each $\langle w, a \rangle \in F$, it was raining in w. Whenever defined, $F + [\![\text{It stopped raining}]\!] = \{\, \langle w, a \rangle \in F \mid \text{it is not raining now in } w \,\}$.

Again following Heim (1982), we crucially assume that both indefinites and pronouns refer to variables, but follow Heim (1991) in assuming that indefinites are subject to the pragmatic condition called the *Novelty Condition*, while definites carry the *Familiarity Condition* as their presupposition.

(27)   a.   **Novelty Condition**: Indefinites must denote variables referring to new file cards.

        b.   **Familiarty Condition**: Definites presuppose that they denote variables referring to old file cards.

New and old file cards are defined as follows.

(28)   A file card x_i is *new* with respect to a file F if for any $\langle w_1, a_1 \rangle, \langle w_2, a_2 \rangle \in F$ such that a_1 and a_2 differ at most at x_i, and for any world w, $\langle w, a_1 \rangle \in F$ iff $\langle w, a_2 \rangle \in F$. Otherwise it is *old*.

The idea is that x_i is new if there is absolutely no information in F as to what individual x_i might be.

For example, the following two sentences have identical FCPs, but they are subject to different conditions, namely, *someone$_1$ coughed* is felicitous as an utterance only if x_1 is new with respect to the file it is updating, while *he$_1$ coughed* presupposes that x_1 is old.

(29)   a. $F + [\![\text{someone}_1 \text{ coughed}]\!] = \{\, \langle w, a \rangle \in F \mid a(x_1) \text{ coughed in } w]\,\}$

        b. $F + [\![\text{he}_1 \text{ coughed}]\!]$ is defined if x_1 is old with respect to F. Whenever defined, $F + [\![\text{he}_1 \text{ coughed}]\!] = \{\, \langle w, a \rangle \in F \mid a(x_1) \text{ coughed in } w]\,\}$

4.2. Dynamic Entailment and d-GIVENNESS

In FCS, we can define the notion of *dynamic entailment* as follows (cf. Groenendijk and Stokhof 1991):

(30) ϕ *dynamically entails* ψ if whenever there is a non-empty file F' such that $F + \phi = F'$, there is a non-empty file F'' such that $F' + \psi = F''$.

We say a phrase XP_E is *d*-GIVEN if there is an antecedent phrase XP_A in the discourse such that XP_E and XP_A dynamically entail each other. Using this notion, we define the identity condition on sluicing as follows.

(31) TP_E can be elided only if TP_E is d-GIVEN.

In order to see how this accounts for the E-type reading, let us consider the following example.

(32) $[_{TP}$ John applied to a_3 graduate school],
       but I don't know why $[_{TP}$ ~~John applied to the$_3$ graduate school~~].

We assume the meanings of the two TPs to be the following.

(33)   a. $F + [\![\text{John applied to a}_3 \text{ graduate school}]\!]$
            $= \{\, \langle w, a \rangle \in F \mid \text{John applied to } a(x_3) \text{ in } w \text{ and } a(x_3) \text{ is a graduate school in } w \,\}$
       b. $F + [\![\text{John applied to the}_3 \text{ graduate school}]\!]$ is defined only if x_3 is old in F and for each $\langle w, a \rangle \in F$, $a(3)$ is a graduate school in w.
            Whenever defined, $F + [\![\text{John applied to the}_3 \text{ graduate school}]\!]$
            $= \{\, \langle w, a \rangle \in F \mid \text{John applied to } a(x_3) \text{ in } w \text{ and } a(x_3) \text{ is a graduate school in } w \,\}$

It is easy to see that whenever there is a non-empty file F' such that

$$F + [\![\text{John applied to a}_3 \text{ graduate school}]\!] = F'$$

$F' + [\![\text{John applied to the}_3 \text{ graduate school}]\!]$ will be defined and will return F'. Furthermore, whenever there is a non-empty file F' such that

$$F + [\![\text{John applied to the}_3 \text{ graduate school}]\!] = F'$$

$F' + [\![\text{John applied to a}_3 \text{ graduate school}]\!] = F'$ as well. Therefore, these two TPs dynamically entail each other, and TP_E can be elided.

Several remarks are in order. Firstly it is crucial that the anaphoric term has a descriptive content. If it were simply a variable without any restrictions on it, then the dynamic entailment from TP_E to TP_A wouldn't go through, as it would not necessarily denote a graduate school. Secondly, it is crucial that the indefinite and definite phrases are co-indexed. If they are not, dynamic entailment doesn't go through, as there is no guarantee that the final update will be a non-empty file. It is also crucial that the Novelty Condition is not a presupposition. If it were a presupposition, TP_E would not dynamically entail TP_A, as TP_A wouldn't be undefined for F'.

However, this result means that the second TP in the following unacceptable example is also d-GIVEN, since mutual dynamic entailment holds for the two TPs.

(34)   *[$_{TP}$ John applied to the$_3$ graduate school],
        but I don't know why [$_{TP}$ ~~John applied to a$_3$ graduate school~~].

However, we correctly rule this out with the Novelty Condition on indefinites. That is, although TP_E here is indeed d-GIVEN, the use of a co-indexed indefinite in the second sentence is pragmatically made infelicitous by the Novelty Condition requiring x_3 to be a new file, which is not the case here, as the opposite is required by the presupposition of TP_A.

How do we then account for the Q-reading? It is accounted for by contra-indexation. Consider the following example.

(35)   [$_{TP}$ John applied to a$_3$ graduate school],
        but I don't know why [$_{TP}$ ~~John applied to a$_5$ graduate school~~].

If the two indefinites were co-indexed, the second sentence would incur a violation of the Novelty Condition, but if they are contra-indexed, as indicated here, the Novelty Condition is satisfied provided x_3 and x_5 are both new in the input file. Furthermore, we can show that the two TPs dynamically entail each other even under contra-indexation. That is, whenever

$$F + [\![\text{John applied to a}_3 \text{ graduate school}]\!] = F'$$

there must a non-null F'' such that

$$F' + [\![\text{John applied to a}_5 \text{ graduate school}]\!] = F''$$

Given the meaning of the sentence, we have

$$F'' = \{\, \langle w, a \rangle \in F' \mid \text{John applied to } a(x_5) \text{ in } w \text{ and } a(x_5) \text{ is a graduate school in } w \,\}$$

Since for each $\langle w, a \rangle \in F'$ John applied to $a(x_3)$ in w and $a(x_3)$ is a graduate school in w, there must be some $\langle w, a \rangle \in F'$ where $a(x_3) = a(x_5)$. Then, F'' must be non-null, and entailment goes through. Therefore, the Q-reading is ruled in.

4.3. Plural File Change Semantics

In order to account for plural quantifiers like *five graduate schools*, we need to extend FCS. A number of ways to account for plural quantification have been put forward in the literature (Chierchia, 1995; van den Berg, 1996; Nouwen, 2003, 2007; Brasoveanu, 2007, 2008, 2010a, b). Here we adopt the idea due to van den Berg (1996) and assume from now on that a file F is a set of pairs consisting of a possible world w and a *set of assignments* A, rather than just a single assignment.

The FCPs of simple sentences are not so different than in the original FCS.

(36)   a. $F + [\![\text{it is raining}]\!] = \{\, \langle w, A \rangle \in F \mid \text{it is raining in } w \,\}$

       b. $F + [\![\text{it stopped raining}]\!]$ is defined only if for each $\langle w, A \rangle \in F$, it was raining in w. Whenever defined, $F + [\![\text{It stopped raining}]\!] = \{\, \langle w, A \rangle \in F \mid \text{it is not raining now in } w \,\}$.

Sentences containing singular indefinites and definites are analysed as follows. We now encode the number information.

(37)   a. $F + [\![\text{someone}_1 \text{ coughed}]\!]$
         $= \{\, \langle w, A \rangle \in F \mid |\{\, a(x_1) \mid a \in A \,\}| = 1 \text{ and } \iota x \in \{\, a(x_1) \mid a \in A \,\} \text{ coughed in } w \,\}$

       b. $F + [\![\text{he}_1 \text{ coughed}]\!]$ is defined if x_1 is old with respect to F and for each $\langle w, A \rangle \in F$, $|\{\, a(x_1) \mid a \in A \,\}| = 1$. Whenever defined, $F + [\![\text{he}_1 \text{ coughed}]\!]$
         $= \{\, \langle w, A \rangle \in F \mid \iota x \in \{\, a(x_1) \mid a \in A \,\} \text{ coughed in } w \,\}$

Plural indefinites and definites are analysed as follows.

(38)   a. $F + [\![\text{John applied to five}_1 \text{ graduate schools}]\!]$
$$= \left\{\, \langle w, A \rangle \in F \;\middle|\; \begin{array}{l} |\{\, a(x_1) \mid a \in A \,\}| = 5 \\ \text{and for each } x \in \{\, a(x_1) \mid a \in A \,\}, \\ x \text{ is a graduate school in } w \text{ and John applied to } x \text{ in } w \end{array} \right\}$$

       b. $F + [\![\text{John applied to the}_1 \text{ five graduate schools}]\!]$ is defined if x_1 is old with respect to F and for each $\langle w, A \rangle \in F$, $|\{\, a(x_1) \mid a \in A \,\}| = 5$ and for each $x \in \{\, a(x_1) \mid a \in A \,\}$, x is a graduate school in w. Whenever defined, $F + [\![\text{John applied to the}_1 \text{ two graduate schools}]\!]$
         $= \{\, \langle w, A \rangle \in F \mid \text{for each } x \in \{\, a(x_1) \mid a \in A \,\}, \text{John applied to } x \text{ in } w \,\}$

One can easily verify that these two sentences dynamically entail each other, and thus our earlier results straighforwardly carry over to plural examples like (4).

In addition, this system is capable of accounting for examples like the following, where the antecedent quantifier is a strong quantifier.

(39)   John applied to half of the graduate schools,

    a.   but I don't know why ~~John applied to half of the graduate schools~~. Q-reading

    b.   but I don't know why ~~John applied to the half of the graduate schools~~. E-type reading

Zooming in on the E-type reading, the key observation here is that the E-type reading amounts to the *maximal* reading where the definite phrase refers to the maximal plurality of graduate schools that John applied to. This can be accounted for with the following semantics for the strong quantifier *half of the NP*. We assume that strong quantifiers are also subject to the Novelty Condition, so x_1 here must be a new file card. Also, to simplify, we disregard the anaphoricity of *the graduate school* n this partitive noun phrase.

(40) $F + [\![\text{John applied to half}_1 \text{ of the graduate schools}]\!]$
$$= \left\{ \langle w, A \rangle \in F \;\middle|\; \begin{array}{l} \dfrac{|\{\, a(x_1) \mid a \in A \,\}|}{|\{\, z \mid z \text{ is a graduate school in } w \,\}|} = \dfrac{1}{2} \\ \text{and } \{\, a(x_1) \mid a \in A \,\} \text{ is a maximal } S \text{ such that for each } x \in S, \\ x \text{ is a graduate school in } w \text{ and John applied to } x \text{ in } w \end{array} \right\}$$

See the works cited here for discussion on the maximality, as well as on further topics on plurality such as collective predication and dependency with other pluralities.

5. Conclusion

In the first half of this paper, we established the empirical lay of the land, claiming that a quantifier in an ellipsis antecedent may license an E-type reading in the ellipsis site. This was shown to be the case for both sluicing, and VP ellipsis, suggesting that this is not a construction-specific phenomenon (contra Romero 2003 and Chung et al. 2011), but rather a consequence of the identity condition on ellipsis.

In the second half, we critically examined Merchant's (2001) analysis of E-type readings, and found it wanting. Our criticisms being that: (i) it under-generates E-type readings in contexts where the quantifier in the antecedent is embedded inside of a scope island, (ii) it is not clear how to constrain $\exists$-type shifting, giving rise to unattested Q-readings licensed by a *wh*-expression in the antecedent, and (iii) it fails to directly capture the requirement that the definite in the ellipsis site be anaphoric on the quantifier in the antecedent clause.

Nevertheless, we agreed with Merchant's account in spirit. Our proposed solution is to reformulate Merchant's focus condition in terms of dynamic semantics. For concreteness, we use Heim's (1982) File Change Semantics for our revised focus condition, which we dub d-GIVENness. Modulo discourse factors, we argued that this accurately predicts the pervasiveness of E-type readings licensed by quantifiers in elliptical contexts. This work opens up the question of whether there are other phenomena motivating a specifically *dynamic* approach to the identity condition on ellipsis.

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Italian 'mica' in assertions and questions[1]

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Abstract. This paper gives an account of the Italian negative particle *mica* as an epistemic common ground management operator signaling denial/negation relative to the speaker. This allows us to provide a unified account of its behavior in assertions and polar questions. Along the way we give an account of biased Italian negative polar questions, arguing that they behave parallel to English biased questions despite surface differences.

Keywords: Semantics, pragmatics, polar questions, negation, Italian, particles.

1. Introduction

This paper gives an account of the Italian particle *mica* at the semantics-pragmatics interface. *Mica* is a negative element, and appears in both assertions and polar questions. In assertions, it indicates a denial, whereas in polar questions, it indicates a prior expectation on the part of the speaker for the negative answer to the question, thus reversing the usual bias of negative PQs (henceforth, NPQs). We propose that *mica* is uniformly a *perspectivally anchored common ground management* operator. That is, it indicates an agent's beliefs about whether some proposition should be part of the common ground. This analysis therefore unifies it with other common ground management operators that have been proposed to account for question bias and denials across languages (Romero and Han 2004, Repp 2013).

The first part of the paper introduces the key data about *mica* and how it is situated in the negative system of Italian. We then proceed to explore the pragmatics of NPQs in detail, showing that despite a single surface position for negation, Italian can show Ladd's ambiguity (Ladd 1981), suggesting that the two languages should receive a parallel analysis. We then develop that analysis by extending Romero and Han (2004)'s analysis of biases in English PQs to Italian. Finally, with the toolbox for NPQs in hand, we return to the perspectival account of *mica*, proposing that in contrast to other CG-management operators, *mica* makes a claim about the common ground from the speaker's perspective.

1.1. Negation and Mica in Italian

Italian uses a preverbal negative marker (*non*) to express sentential negation:[2] The particle *mica* can appear as a *discontinuous* element of *non*, as in B's response in (3), or as an *autonomous* negative element (Cinque 1976) as in (4), without any difference in interpretation.

(1)   Gianni **non** ha telefonato.   (2)   **Non** fa   freddo a Roma.
        Gianni NEG has phoned.   NEG does cold   at Rome.
        'Gianni didn't call.'   It's not cold in Rome.

(3)   A: Fa freddo fuori. 'it's cold outside.'   (4)   A: Fa freddo fuori. 'it's cold outside.'
        B: **Non** fa (**mica**) freddo.   B: **Mica** fa   freddo.
           NEG does (MICA) cold.   MICA does cold.
           'It's not (MICA) cold.'   'NOT-MICA it's cold.'

Following Cinque (1976), Zanuttini (1997), we assume that autonomous *mica* is derived from discontinuous *mica* via movement: *mica* moves and takes the place of *non*, incorporating its negative meaning. As a discontinuous element of *non*, *mica* follows verbal elements (auxiliaries, modals, participles), but cannot precede the first one of them and it cannot occur after non-verbal elements that follow the verbal group (Cinque 1976). The spaces in the sentence below show where mica can occur in a sentence, the stars the places where it cannot occur:

(5)   Non * puo' ‿ essere ‿ stato ‿ vinto ‿ da quella schiappa *.
        NEG * can ‿ be   ‿ been ‿ won ‿ by that   fool   *
        'He cannot have been beaten by that fool.'   (Cinque 1976)

2. Using *mica* in assertions signals contrast / denial

Unlike plain negative assertions, *mica* in declaratives requires a prior claim or salient expectation to deny (Cinque 1976). We identify three types of context that license the use of *mica*: *direct contradiction* where *mica* is used to deny a previous utterance, or the presupposition/implication of a previous utterance; *speaker's expectation* where *mica* is used by the speaker to deny one of her own expectations and *implied inference*, where *mica* is used to deny a proposition that the speaker is implicitly attributing to the addressee.[3]

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[2]We will focus exclusively on the use of *mica* in standard Italian. See Garzonio & Poletto (2009) and Pennello & Pescarini (2008) for differences between standard Italian and Northern Italian dialects in the use of *mica* and Visconti (2008) for a diachronic approach.

[3]The choice between autonomous and discontinuous *mica* in the examples is irrelevant to the interpretation.

(6)   **Direct contradiction** (A's utterance asserts, presupposes, or implies p)
    a.   A: Mario ha pianto quando la ragazza l'ha lasciato.
                'Mario cried when his girlfriend broke up with him.'
        S: Non é vero. Mario **mica**   ha pianto quando la ragazza l'ha   lasciato.
                NEG is true. Mario **MICA** has cried   when   the girlfriend him-has left.
                'That's not true. Mario NOT-MICA cried when his girlfriend left him!'

(7)   **Speaker's expectation** (S signals that (s)he previously expected p)
    a.   Context: S is baking a cake but does not have all the ingredients. When she tries it,
            she is surprised that the cake turned out quite well.
        S: Ah però! **Mica** é venuta   male la torta.
                Ah!   **MICA** is turned.out bad   the cake
                'Oh! the cake NOT-MICA turned out bad!'

(8)   **Implied inference** (S infers that p is expected by A)
    a.   Context: S tries to pick up a cat from the street; the cat looks scared.
        S: Non avere paura, **mica** ti   faccio male.
                NEG have fear,   **MICA** to.you do.1sg harm
                'Don't be afraid, NOT-MICA I am going to hurt you!'

In all of the above examples, plain negation would also be acceptable. However, unlike plain negation, *mica* is infelicitous when there is not a previous claim/expectation to deny. Compare the minimally different dialogues below, where the negated sentence with *mica* is marked in the first dialogue, but acceptable in the second. The difference is that in (10), A asks a question that signals he is wrongly assuming that S's sister has a car, licensing *mica*.

(9)   Context (NYC Party): S and A live in Amherst and want to go to a party in NYC.
    A: How are we going to get there?
    S: Non lo so.   Mia sorella **non** ha (**#mica**) la macchina questo
          NEG it know.1sg. My sister **NEG** has (**#MICA**) the car   this
          fine settimana.
          weekend.
          'I don't know. My sister does not (#MICA) have the car this weekend.

(10)   Context (NYC Party)
    A: How are we going to get there? Can your sister give us a ride?
    S: Mia sorella **non** ha (**mica**) la macchina. Ha   soltanto 13 anni!
          My sister   **NEG** has (**MICA**) the car.   Have.3sg only   13 years!
          'My sister does not (MICA) have a car, she is only 13!'

There are two take-home points from the data presented so far. First, *mica* is not just for surface denials: it can deny a proposition that has never been expressed linguistically, including when that

has been simply inferred as a belief of another participant (up to and including a cat). Second, *mica* in declaratives occurs in a subset of the environments where *non* occurs.

2.1. Previous proposal for *mica* in assertions: Cinque 1976

Cinque (1976) (see also Zanuttini 1997, Penello and Pescarini 2008, Pescarini 2009) suggests that *mica* in declaratives is a presupposition trigger: a sentence of the form *(non) mica p* asserts that $\neg p$ and presupposes that p was expected. We sketch a particular version of this in (11):

(11)   a. $\llbracket \textbf{NON } \alpha \rrbracket^c = \neg \llbracket \alpha \rrbracket^c$
        b. $\llbracket \textbf{MICA } \alpha \rrbracket^c = \llbracket \textbf{NON MICA } \alpha \rrbracket^c = \neg \llbracket \alpha \rrbracket^c$
           Defined in c only if $\llbracket \alpha \rrbracket^c$ is assumed by some participant in c.

This directly captures the distributional facts. First, it straightforwardly predicts that *mica* sentences will be good in a subset of the cases where *non* sentences are good. This is because the presupposition introduced in (11-b) as a definedness condition leads to *mica* sentences being defined in a subset of the context where regular negative sentences are defined, and having the same truth-conditions when defined. The idea also captures the intuition about when *mica* is licensed: the presupposition is intended to cover cases where any participant (including the speaker) said or implied or acted as if they believed $\llbracket \alpha \rrbracket^c$. The case where a speaker is aware of their own prior assumptions, even if they haven't communicated them, is just another special case.

Despite capturing much of the distributional facts we have shown so far, we identify several areas for development of this account (at least as we have stated it). First, we will show in the next several sections that this account does not extend to *mica* in polar questions in any obvious way. Second, even for basic *mica* assertions there are some scopal facts that aren't predicted. As Penello and Pescarini (2008) discuss, *mica* interacts with other scopal elements in a way different from regular negation. In particular, while regular negation is ambiguously scoped with respect to deontic modals, *mica*-negation must scope above.[4] These facts aren't incompatible with the presuppositional proposal per se, but they also aren't explained by it, at least on a naive syntax: why should *mica* negation need to scope higher than regular negation?

(12)   **Non** devi   guidare.
        NEG must.2sg drive
        a.   'You must not drive' (MUST $\gg$ NEG)
        b.   'It is not the case that you must drive. / You don't have to drive' (NEG $\gg$ MUST)

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[4]As usual, the judgment does not differ for autonomous *mica* vs. discontinuous *mica*, which provides further evidence that the apparently low position of *mica* in the discontinuous case is a surface phenomenon.

(13)   **Mica** devi   guidare. / **Non** devi   **mica** guidare.
        Mica must.2sg grdive   / **NEG** must.2sg **mica** drive.
        a. #You must not drive. (#MUST ≫ NEG)
        b. You don't have to drive. (NEG ≫ MUST)

3. *Mica* in polar questions triggers bias reversal

Mica can also occur in polar questions (PQs), which in Italian have the same word-order as declaratives, though different intonation.[5] Across languages, negative polar questions (NPQs) are known to trigger an *epistemic bias* effect (Ladd 1981, Büring and Gunlogson 2000, van Rooy and Safarova 2003, Romero and Han 2004, AnderBois 2011 a.o.). For instance, an English NPQ, such as *Don't you smoke?*, conveys that the speaker expected the positive answer to the question to be true, a 'positive epistemic bias', and is now requesting confirmation for that (positive) expectation.

Italian NPQs also trigger a positive epistemic bias, paralleling English (first shown in Frana and Rawlins 2013). However, when *mica* is added to an NPQ, it does not simply reinforce that positive epistemic bias (which we might expect given the assertion case), but reverses it. A *mica*-PQ triggers a *negative* epistemic bias, and NPQs and Mica-PQs have opposite felicity conditions. In both scenarios below, Clara has an expectation about whether Miles has eaten; in the first version she expects him to have eaten (S expected p), and in the second version she expected him to not have eaten (S expected $\neg p$). Contextual evidence in each seemingly contradicts these expectations.[6] In the second scenario, NPQs in both languages are infelicitous – NPQs of this type cannot be used to double-check a positive implied inference, or a negative prior expectation. In contrast, *mica* is felicitous here, and can be used to attempt to confirm a negative prior expectation.

(14)   **Context: good manners v. 1** (S expected p, evidence against p)
        Clara invites Miles for drinks late in the evening and tells him to come after dinner. When he gets there, Miles asks if she has any food. Clara asks him:
        a. S: Didn't you eat already? (English NPQ)
        b. S: **Non** hai   giá   mangiato?
                 NEG have.2sg already eaten?
                 'Didn't you eat already?'   (Italian NPQ)
        c. S: #**Mica** hai   giá   mangiato?
                 mica have.2sg already eaten?
                 'NOT-MICA ate already?'   (Mica-PQ)
        d. S: #Non hai **mica** giá mangiato?   (Mica-PQ)

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[5] As has been noted in the literature, *mica* does not occur in constituent (*wh-*) questions.

[6] As before, the alternative word order (discontinuous *mica*) has equivalent acceptability conditions. From now on, we will stop bringing up this alternative word order. Unless otherwise noted, this word order is available and has equivalent meaning as the autonomous *mica* order.

(15)   **Context: good manners v. 2** (S expected $\neg p$, evidence for p)
        Clara invites Miles for dinner and makes clear to him that she will prepare her best dishes.
        When he gets there, Miles barely touches any food. Clara asks him:
        a.   S: #Didn't you eat already?   (English NPQ)
        b.   S: #**Non** hai giá mangiato?   (Italian NPQ)
        c.   S: **Mica** hai giá mangiato?   (Mica-PQ)
        d.   S: **Non** hai **mica** giá mangiato?   (Mica-PQ)

Summing up, in assertions, *mica* can be used to deny the speaker's previous expectation (S signals she had a prior expectation for p). In Mica-PQs, on the other hand, the polarity of the licensing expectation (speaker's epistemic bias) has to be negative for *mica* to be licensed (S signals she previously expected $\neg p$). Thus, Mica-PQs and NPQs are in complementary distribution. Regular negation (*non*) and *mica* in assertions are not in complementary distribution. In view of these differences, it isn't obvious how one might extend the presuppositional account of *mica* in assertions to cover PQs, or extend the generalization above in the other direction.[7]

4. Italian and English negative polar questions

The (classic) puzzle of positive vs. negative polar questions is that on standard analyses, the positive and negative versions are denotationally identical. For example, on Hamblin's (1973) account, the equivalence in (16) holds. However, English speakers do not use polar questions indifferently. Any speaker of English knows that the three questions in (17) have different felicity conditions:

(16) $[\![\textbf{whether } p]\!]=[\![\textbf{whether } \neg p]\!]= \{p, \neg p\}$ (because $\{\neg p, \neg\neg p\} = \{p, \neg p\}$)
(17)   a.   Is it raining? (Positive Polar Question / PPQ)
        b.   Isn't it raining? (Negative Polar Question / NPQ with high negation)
        c.   Is it not raining? (NPQ with low negation)

We have so far seen that Italian NPQs parallel English NPQs with preposed negation. This is not quite the full story. First, we need to address whether Italian NPQs have readings corresponding to the non-preposed negation cases, and second, we need to address whether Italian NPQs and *mica* PQs have a reading that we have so far not discussed yet: suggestion readings.

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[7]Foreshadowing our proposal, an account in terms of current evidence or an implied inference of $\neg p$ won't work: *mica* is felicitous in contexts where there is no evidence one way or the other. See discussion of (27) below.

4.1. The polarity of the proposition double-checked (inner vs. outer readings)

NPQs sound very natural in contradiction scenarios. These are cases in which the speaker had a previous expectation for p and the context, or the addressee, are providing partial evidence against p. When faced with epistemic conflict, the speaker might decide to ask an NPQ with one of these two intentions in mind: he or she may intend to confirm, or "double-check", their (positive) prior expectation for p (outer negation reading) or to double-check the (new) implied proposition that $\neg p$ (inner negation reading) (C.f. Ladd 1981, Bring and Gunlogson 2000, Romero & Han 2004). The example below brings out the two readings intuitively. In both cases, the polarity of the prior epistemic bias is positive. It is just the proposition that gets 'double-checked' which changes: a prior expectation for p vs. a (new) implied inference that $\neg p$.

(18)   Context: Hampshire Mall (**Contextual evidence contradicts prior belief that** p)
         S wants to go to the Hampshire Mall and has been told that the B43 stops there. While on route, the bus goes past what the speaker thought was his stop. S asks the driver:
    a.   (What're you doing?) Doesn't this bus stop at the Hampshire Mall?
          $\rightsquigarrow$ S had prior expectation that the bus stopped here (p) and thinks driver may have skipped the stop, so is double-checking the prior expectation that p. (Outer reading)
    b.   (Oh no!) Does this bus not stop at the Hampshire Mall?
          $\rightsquigarrow$ S had a prior expectation that the bus stops there (p) and now thinks she may have been wrong, so is double-checking the implied inference that $\neg p$.   (Inner reading)

We have already seen that Italian NPQs are only felicitous in contexts compatible with the speaker having a prior positive epistemic bias, but what about the choice of the proposition double-checked? Does Italian also distinguish between inner and outer readings? The key diagnostic used in the literature, introduced by Ladd (1981) and discussed in depth by Romero and Han (2004), is that of polarity licensing. In English, the two positions for negation show different behavior with respect to licensing of NPIs and PPIs. In particular, Ladd showed that a PPI disambiguates an NPQ in favor of the *outer* reading and that an NPI disambiguates an NPQ in favor of the inner reading. Another way of putting this is that inner negation licenses NPIs and anti-licenses PPIs, whereas outer negation does neither.[8]

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[8]The % here indicates cross-speaker variation. For the majority of native speakers we have consulted (including one of the authors), NPQs with preposed negation unambiguously have outer readings. There seems to be agreement across speakers with respect to NPQs with non-preposed/low negation, which correlate with inner readings only. The situation is summarized below.

(i)   **Group 1**: High negation: only outer readings
                  Low negation: only inner readings
(ii)   **Group 2** (includes Ladd 1981, and the dialect analyzed by Romero and Han)
                  High negation: ambiguous between inner and outer readings
                  Low negation: only inner readings

(19) **A PPI disambiguates in favor of the outer reading**
    A: Ok, now that Stephen has come, we are all here. Let's go.
    S: Isn't Jane coming **too**?   ($\leadsto$ double-check prior expectation that Jane comes)
    S′: *Is Jane not coming **too**?

(20) **An NPI disambiguates in favor of the inner reading**
    A: Now that John said he is not coming, it's going to be just me and you. We should cancel the party.
    S: Is Jane not coming **either**? ($\leadsto$ double-check implied inference that J. isn't coming)
    S′:%Isn't Jane coming **either**?

In Italian, we can construct a similar diagnostic using certain 'n-words' and their positive counter-parts. We will employ the polarity items *anche* ('too/also') and *neanche* ('neither') to distinguish between the two readings.[9] The data show that Italian NPQs can have both inner and outer readings, despite having only one surface position for negation. For instance, in the contradiction scenario in (21), S is double-checking the proposition p "that A is (also) going". The motivation behind the double-checking move is an apparent epistemic conflict: contextual evidence contradicts S's prior expectation for p.

(21)   Drinks Context 1: S, H , and A are out for drinks. S and B want to go to a bar and start walking towards it. A appears to stay behind. S asks A:[10]
    S: (Che fai?) **Non** vieni   **anche** tu con noi?
        (What does?) NEG come.2sg too   you with us?
        '(What are you doing?) Aren't you coming too?'

NPQs also license NIs; moreover, when *neanche* ('neither') is used in an NPQ, it disambiguates in favor of the inner reading (double-checking implied contextual inference for $\neg p$). In the scenario in 59) below, S is double-checking the implied proposition $\neg p$, i.e. "that A is not going"; as before the motivation behind the double-checking move is epistemic conflict.

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[9]As shown by the contrasts below, the PI *anche* can be used only in positive sentences. On the other hand, the NI *neanche* - when it occurs post-verbally – is only grammatical in a negative sentence.

(i)   Vengo   anche io
        come.1sg too   I
        'I am coming too.'

(ii)   *Non vengo   anche io
        NEG come.1sg too   I

(iii)   *Vengo   neanche io
        come.1sg neither I

(iv)   Non vengo   anche io
        NEG come.1sg too   I
        'I am not coming either'

[10]This context is designed around the presupposition triggered by *anche*, that someone other than A is going.

(22)   Drinks context 2: S, H, A and B are out for drinks. We want to go to a different bar. B tells us she is done for the night and says goodbye. We start walking toward the bar, but A looks like they are staying behind. S asks A:[11]

S: (Oh no!) **Non** vieni   **neanche** tu   con noi?
              NEG come.2sg neither   you with us?
       '(Oh no!) are you not coming either?'

Ladd argues on the basis of the PI facts that for English the difference between inner and outer readings is a genuine scopal ambiguity, involving the scope of negation and an operator whose nature remains to be determined. When the operator intervenes between negation and the polarity item, negation loses its usual (anti-)licensing ability. We propose that this analysis can be extended to Italian. In the case of outer negation readings, sentential negation is outside the scope of the operator (**NEG ≫ OP [p]**), thus the proposition being double-checked has positive polarity and NIs are not licensed and PIs are not anti-licensed. On the other hand, in the case of inner negation readings, sentential negation is below the operator (**OP ≫ NEG [p]**), and the proposition being double-checked has negative polarity, here NIs are licensed and PIs are anti-licensed.

4.2. Suggestion scenarios

So far the descriptive generalizations for preposed negation have been stated in terms of the speaker's expectations, even though the scenarios we have presented also involve evidence. The reason for this is that preposed negative PQs are also licensed in neutral evidence contexts, with what have been described as 'suggestion' readings. As noted by Ladd, an NPQ in a suggestion scenario can only have the outer negation reading (double-checking a prior positive expectation).

(23)   **Ladd's suggestion scenario** (neutral contextual evidence)
       Kathleen and Jeff just come from Chicago on the Greyhound bus to visit Bob in Ithaca.
       B: You guys must be starving. You want to get something to eat?
       K: Yeah, isn't there a vegetarian restaurant around here? Moosewood, or something?
       K′: #Yeah, is there not a vegetarian restaurant around here?

(24)   Italian Variant: Clara has just arrived to visit her friend Luigi in Napoli.
       L: You must be starving, shall we we get something to eat?
       C: Si,   certo. Non c'era   una pizzeria buona da queste parti?   Da Michele, o un
             Yes, sure. NEG there.is a   pizzeria good in this   vicinity? By Michele or a
             nome del   genere?
             name of.the kind
             'Yes, sure. Wasn't there a good pizzeria around here? Da Michele or something?

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[11]This context is designed around the presupposition triggered by *neanche*, that someone other than A is not going.

In this famous example, K has some prior expectation that this restaurant exists, but she is unsure; the contextual evidence is neutral. The effect of this NPQ is to suggest a resolution to some other salient question (e.g. where to go eat), by double-checking the speaker's prior expectation that p. This type of question therefore lines up with the 'outer reading'. Italian NPQs are also acceptable in suggestion scenario, illustrated by (24), thus reinforcing the parallel to English.

In summary, Italian NPQs behave in a parallel fashion to English NPQs: (i) they can signal information about the epistemic state of the questioner, (ii) they show the inner/outer ambiguity introduced by Ladd (revealed by the use of n-words), and (iii) on the outer reading can be used in neutral evidence contexts. What is crucial is that they involve a prior positive expectation on the part of the speaker.

4.3. *Mica* and expectations vs. evidence

As shown in (14) and (15) (the 'Good manners' scenarios), When *mica* is used in an NPQ, it reverses the expectation of the speaker's bias. That is, a regular NPQ signals the speaker's prior expectation for p, while a Mica-PQ signals the speaker's prior expectation for $\neg p$. The discussion of NPQs raises two gaps that we fill in.

First, *mica*-PQs do require the prior negative expectation on the part of the speaker, in contrast to regular PPQs, which are also compatible with a prior negative bias, but do not require it. For example, *mica* is inappropriate in neutral interview contexts in which the speaker does not intend to signal a previous expectation:

(25)   Interview context.
    a.   É   sposato? (PPQ)
         be.3sg married?
         'Are you-formal married?'
    b.   #Non é   sposato? (NPQ)
         NEG be.3sg marriedy
         'Aren't you-formal married?'
    c.   **MICA** é   sposato? (Mica-PQ)
         MICA   be.3sg marriedy
         'Aren't you-formal **mica** married?'

Second, like the outer NPQ, *mica* is compatible with neutral evidence contexts. One key case like this is the use of *mica* in polite questions, which can roughly be paraphrased using 'by any chance' in English, shown in (26). This question can be neutral as to whether there is any reason to think that the hearer will know the password – the use of *mica* in polite questions signals that a negative

reply is expected from the speaker, and thus it takes some weight off the addressee's shoulders. A second case is shown in (27), where the speaker intends to double-check their expectation that $\neg p$, and can do so even with no evidence to the contrary.

(26)   Sai **mica** la password del   computer di Mary?
        know **MICA** the password of.the computer of Mary

        'By any chance do you know Mary's computer password?'

(27)   Context: Mother and son (**S expected** $\neg p$**, neutral evidence**): Your mother told you that
        I am bad influence and that you shouldn't hang out with me. We still want to hang out but
        I don't want to get in trouble with your mother so I asked you to not tell her when you
        come over. As I arrive, I get a bit paranoid and I ask you:
        a.   S: #**Non** hai detto a tua madre che venivi a casa mia?
        b.   S: **Mica** hai detto a tua madre che venivi a casa mia?

5. Analyzing biases in Italian polar questions

In this section we develop an account of Italian biased polar questions in the framework of Romero and Han (2004) (R&H), who gave a comprehensive analysis of the facts of English NPQs, as well as biased positive PQs with *really*. Their proposal builds on Ladd's idea of a scope ambiguity. They suggest that biased PQs involve what Repp (2013) terms a *common ground management* operator, indicating (un)certainty about whether a given proposition should (not) be in the Common Ground in a Stalnakerian sense. Their original proposal was that this operator in English can scope both above and below negation, leading to the two readings (inner vs. outer). On top of this semantic proposal, they derive the epistemic inference about the speaker (the epistemic bias) via neo-Gricean reasoning about why a speaker would choose to formulate the question in a particular way.

Romero and Han (2004) propose that the operator is what they termed VERUM, signaling certainty that the prejacent should be added to the common ground. VERUM can be realized with the particle *really*, as well as by focal stress on polarity elements (i.e. comparable to Höhle's (1992) Verum focus). This operator has the semantics of an epistemic modal, though it operates at a 'meta-level' with respect to discourse. The following is R&H's entry for VERUM .[12]

(28) $[\![\mathbf{VERUM}]\!]^x = [\![\mathbf{really}]\!]^x =$
$$\lambda p_{\langle s,t \rangle} . \lambda w_s . \forall w' \in Epi_x(w) : (\forall w'' \in Conv_x(w') : (p \in CG_{w''}))$$
        $= \text{FOR-SURE-CG}_x(p).$ Roughly: $g(i)$ is sure that p should be added to the CG

(29)   I really am tired.

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[12]In what follows, $Epi_x(w)$ the set of worlds conforming to x's knowledge in w; $Conv_x(w')$ the set of worlds where all the conversational goals of x in w' are fulfilled (e.g attain maximal information while preserving truth); CG_w is the Stalnakerian common ground at a world w, i.e. the set of propositions that the speakers assume to be true at w (c.f. Stalnaker 1978).

CG-management operators are perspectival operators: in assertions x is bound to the speaker, but in questions x is bound to the hearer. Intuitively, by uttering (29), the speaker is making a meta-conversational move by expressing a high degree of confidence about adding p (*I am tired*) to the CG. When used in a PQ, VERUM interacts with negation, turning a regular PQ into a meta-conversational question asking the hearer about their degree of certainty about p in various ways – e.g. are they really certain that p, are they really certain that not p, and are they not really certain that p. Romero (2014) revises this slightly, building on Repp (2013) – in the case of the outer reading, there is no distinct operator from negation, but rather a meta-conversational strong negative operator that Repp termed FALSUM. FALSUM indicates that 'there are zero degrees of strength for adding a proposition to the Common Ground'. We adopt this revision here. The proposal then is that the LFs for *really* PQs and the two types of biased NPQs are as follows:

(30)   PPQ with 'really': [Q [VERUM [p]]] ('Is Jane really going?' / 'Veramente viene Jane?')
(31)   Inner NPQ: [Q [VERUM [¬ [p]]]] ('Is Jane NOT going?' / 'Non viene neanche Jane?')
(32)   Outer NPQ: [Q [FALSUM [p]]] ('Isn't Jane going?' / 'Non viene (anche) Jane?')
(33) $[\![\textbf{FALSUM}]\!]^x = \quad \lambda p_{\langle s,t \rangle} . \lambda w_s . \forall w' \in Epi_x(w) : (\forall w'' \in Conv_x(w') : (p \notin CG_{w''}))$
        $= \text{FOR-SURE-NOT-CG}_x(p).$

Romero & Han supplement the syntax/semantics proposal with two additional pragmatic pieces. First, VERUM questions (and by extension FALSUM questions) involve *biased partitions*, i.e. a set of polar alternatives where each alternative contains a CG-managing operator.[13] Meta-conversational moves are subject to a discourse economy constraint (R&H's *Economy Principle*: do not use a meta-conversational move unless necessary, i.e. to resolve epistemic conflict/to ensure Quality), which leads the hearer to reason about the motivation behind the speaker's choice of using a meta-conversational question (as opposed to a regular PQ) and thus to draw inferences about the speaker's epistemic state. Second, building on ideas from Bolinger (1978), R&H propose that the choice of alternative that gets pronounced indicates something about the speakers' expectations for answers (R&H label this other type of bias, *the intent of the questioner*).[14] We will indicate the spelled-out alternative by highlighting it and refer to it as the *B-emphasized* alternative.

(34)

	Biased PPQ:	Is Jane **really** going? (/'Veramente viene Jane?')
	LF:	Q_h [VERUM$_h$ [Jane is going]]
	Biased partition:	{FOR-SURE-CG$_h(p)$, ¬FOR-SURE-CG$_h(p)$}

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[13]For simplicity we will stick with R&H's original proposal that the CG-management component of VERUM/FALSUM is part of the at-issue content. More recently, Romero (2014) has suggested that this should be moved into non-at-issue content, following other work on particles; in Frana & Rawlins (2016, in prep) we develop an account along these lines for *mica* and argue that it in fact improves on the at-issue account.

[14]A closely related idea is developed by van Rooy and Safarova (2003) using the notion of a 'utility value', though we do not have space to develop the comparison here.

What does B-emphasis do? Here we depart somewhat from R&H in connecting B-emphasis directly to likelihood/belief.[15]

(35)   **B-emphasis in meta-conversational questions**: By B-emphasizing a CG-management alternative A in a polar question, S indicates that they expect A to be true.

Since these are meta-conversational questions, the alternatives are meta-conversational propositions. In the *really* example in (34), therefore, the speaker indicates that they expect that the hearer is certain that p (that Jane is going to the party) should be added to the common ground. By Economy, however, they must be signaling this in order to resolve some Quality-related dilemma. If the speaker takes the hearer to be certain about a given proposition, then this can't be a neutral context: there must be some reason for that certainty. Therefore, there must be an epistemic conflict. If the speaker thinks the hearer is biased towards p, the speaker must have expected $\neg p$, i.e. that Jane is not going. This derives the negative epistemic inference for PPQs with *really*. The reasoning for inner and outer readings of NPQs is quite similar.

(36)

Inner NPQ:	Non viene neanche Jane? /Is Jane not coming either?
LF:	Q_h [VERUM$_h$ [¬ [Jane is going]]]
Biased partition:	{FOR-SURE-CG$_h(\neg p)$, ¬FOR-SURE-CG$_h(\neg p)$}

Here the speaker endorses the possibility that the hearer is certain about adding $\neg p$ (that Jane is not going) to the common ground. By Economy, they must be signaling this in order to resolve some Quality-related dilemma. Again, because of the high certainty, there must be an epistemic conflict, and so the speaker must therefore have an expectation for p (that Jane *is* going), and wants to double-check the implied proposition that she isn't.[16] The outer reading is a bit more complex:

(37)

Outer NPQ:	Non viene anche Jane? /Isn't Jane coming too?
LF:	Q_h [FALSUM$_h$ [Jane is going]]
Biased partition:	{FOR-SURE-NOT-CG$_h(p)$, ¬FOR-SURE-NOT-CG$_h(p)$}

Here, the speaker endorses the possibility that the hearer has *zero* degree of certainty about adding p to the CG, which is compatible with evidence against p, or lack of evidence (for either p or $\neg p$). If the hearer has signaled that they believe p to be false, this leads to the now-familiar epistemic

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[15]We will not try to give an account that makes predictions from B-emphasis for PQs without a meta-conversational operator; see van Rooy and Safarova (2003), AnderBois (2011) for extensive discussion of such cases.

[16]On R& H's proposal, VERUM is optional for negation in the low position, explaining why non-preposed negation in English can occur in the absence of a previous bias, e.g. brochure-questions 'Have you not been sleeping well lately? Then try this pill.'

conflict case and the hearer must have had the opposite expectation (for p). If the hearer signaled no bias for either p or $\neg p$, then the speaker would be justified in raising the meta-question only in a suggestion scenario, i.e. to double check their prior expectation that p. Which way this 'ambiguity' is resolved, i.e. which reason the speaker had for asking a biased question, will typically be disambiguated by the context.

6. 'Mica' as a perspectival operator

Frana and Rawlins (2013) provide the first account of *mica*'s bias reversal effect in PQs. Working within the context of R&H's VERUM analysis, they propose that *mica* is a double-negation VERUM operator, with negation scoping both above and below VERUM. This instantiates the fourth permutation of negations and VERUM not covered in R&H's original discussion. Here, we adapt the original proposal to the modification already introduced before from Romero (2014), namely that any configuration in which negation outscopes VERUM should be replaced by FALSUM.[17]

(38)   Mica-PQ: Mica vieni tu?
   a.   LF: $[Q_h \, [\text{FALSUM}_h \, [\neg_{\text{low}} \, p \,]]]]$
   b. $\{\underline{\text{FOR-SURE-NOT-CG}_h(\neg p)}, \neg\text{FOR-SURE-NOT-CG}_h(\neg p)\}$

The reasoning that Frana & Rawlins proposed is directly based on the R&H reasoning for the outer negation readings. The speaker endorses the possibility that the hearer has *zero* degree of certainty about adding $\neg p$ to the CG, which is compatible with evidence for p, or lack of evidence (for either p or $\neg p$). If the hearer has signaled that they believe p to be true, this leads to the familiar epistemic conflict case and the hearer must have had the opposite expectation (for $\neg p$). If the hearer signaled no bias for either p or $\neg p$, then the speaker would be justified in raising the meta-question only in a suggestion scenario, i.e. to double check their prior expectation that $\neg p$.

Unfortunately, this account of *mica* has several problems. First, this analysis makes exactly the wrong predictions for assertions: they would be predicted to have the form FOR-SURE-NOT-$\text{CG}_s(\neg p)$. Rather than expressing a denial of p on the part of the speaker, this would deny $\neg p$! Second, this proposal makes the wrong predictions about polarity items. In particular, it predicts that *mica*-PQs should license NIs (e.g. *neanche*) and anti-license PIs (e.g. *anche*) because of the lower negation. These predictions are wrong: *mica* PQs behave just like English outer NPQs with respect to licensing (in contrast to Italian NPQs, which allow both items under different readings).

(39)   (Che fai?)   **Mica** vieni   {**anche** / *neanche} tu   con noi?
         (what does.2sg?) MICA comes.2sg **too**   you with us?
         'Are you mica coming too?'

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[17]The original proposal was that 'mica' questions have an LF: $[Q \, [\neg \, [\text{VERUM} \, [\neg \, p]]]]$.

Third, this proposal predicts that *mica* PQs should have the same interpretation as double-negative PQs, discussed extensively by AnderBois (2011) albeit in a different framework. This prediction is once again wrong. For example, in Good Manners v. 2, double-negative PQs are infelicitous despite the felicity of *mica*. While the direction of bias in *mica* PQs is apparently similar, the fine-grained distribution of the two question types is not.

(40)   **Context: good manners v. 2** (S expected $\neg p$, evidence for p)
         Clara invites Miles for dinner and makes clear to him that she will prepare her best dishes. When he gets there, Miles barely touches any food. Clara asks him:
         a.   #Didn't you not eat already?
         b.   **Mica** hai gia' mangiato?

6.1. Perspectival 'mica' in polar questions

The CG-managing operators VERUM and FALSUM developed by Romero & Han / Repp are perspectival operators: they introduce entailments about the state of the Common Ground from the perspective of one of the participants in the discourse, determined by the speech act operator. In assertions VERUM/FALSUM are speaker-oriented, and in questions, they are hearer-oriented.

Our proposal changes this: *mica* introduces a FALSUM operator that, rather than having bound perspective variables, has an aspect of its perspective necessarily anchored to the speaker. We will show that this inverts the pragmatic reasoning triggered by the use of a CG-management operator, leading to a reversal in the polarity of the bias on the part of the participants in discourse.

The proposal has two parts. First, in assertions, *mica* signals a FALSUM operator – that is, it indicates a species of meta-linguistic negation. Second, this FALSUM operator is obligatorily speaker-oriented, in terms of projecting the future of the discourse. In (41) we present first a slightly modified version of the Repp FALSUM operator. Given some proposition p, this returns true just in case given x's knowledge, in all discourse states compatible with y's conversational goals, p is not in the common ground. The difference between (41) above and the original version is that we have separated out the two anchors. We take x to be always bound by the speech-act operator: the epistemic perspective taken must be the same as the perspective of the speech act. The anchor y we suggest is the one that is obligatorily speaker-oriented for *mica*, but not for FALSUM in general.

(41) $[\![\mathbf{FALSUM}]\!]^{x,y,c} = \lambda p_{\langle s,t \rangle} \, . \, \lambda w_s \, . \, \forall w' \in Epi_x(w) : (\forall w'' \in Conv_y(w') : (p \notin CG_{w''}))$
(42) $[\![\mathbf{mica}]\!]^{x,c} = [\![\mathbf{FALSUM}]\!]^{x,s_c,c}$

In assertions, nothing changes: both x and y would be bound to the speaker regardless. However, polar questions ordinarily trigger perspective shift – on R&H's proposal, VERUM and FALSUM are speaker-oriented in assertions but hearer-oriented in questions (for the outer reading, we would then have FALSUM$_{h_c,h_c}$). Our proposal is that this second index remains anchored to the speaker in Mica-PQs, as illustrated in (43). We pair this with the full denotation for a regular NPQ in (44).

(43) $[\![\mathbf{Q}_{h_c} \, [\mathbf{mica}_{h_c} \, \mathbf{TP}]]\!]^c = [\![\mathbf{Q}_{h_c} \, [\mathbf{FALSUM}_{h_c,s_c} \, \mathbf{TP}]]\!]^c$
$= \{\underline{\lambda w_s \,.\, \forall w' \in Epi_{h_c}(w) : (\forall w'' \in Conv_{s_c}(w') : (p \notin CG_{w''}))},$
$\qquad\qquad\qquad \lambda w_s \,.\, \neg\forall w' \in Epi_{h_c}(w) : (\forall w'' \in Conv_{s_c}(w') : (p \notin CG_{w''}))\}$
    (Where $p = [\![\mathbf{TP}]\!]^c$)

(44) $[\![\mathbf{Q}_{h_c} \, [\mathbf{FALSUM}_{h_c,h_c} \, \mathbf{TP}]]\!]^c =$
$= \{\underline{\lambda w_s \,.\, \forall w' \in Epi_{h_c}(w) : (\forall w'' \in Conv_{h_c}(w') : (p \notin CG_{w''}))},$
$\qquad\qquad\qquad \lambda w_s \,.\, \neg\forall w' \in Epi_{h_c}(w) : (\forall w'' \in Conv_{h_c}(w') : (p \notin CG_{w''}))\}$

In (43) the speaker asks the hearer to accept or reject the possibility of the speaker committing to not adding p to the CG, and indicates that the most likely resolution is that adding p is not compatible with s_c's goals, i.e. the speaker has zero degree of certainty for adding p. This kind of question is meta-conversational, and therefore the speaker must have a quality dilemma. In this case the starting point for the reasoning is inverted from the pragmatic reasoning for (44) (which is unchanged): the speaker indicates that they have zero degree of certainty for adding p to the common ground, which is compatible with S having some prior expectation for $\neg p$ or lack of evidence. Thus, either they want to double-check some implied inference that p (in the case of epistemic conflict), or they are hoping that the hearer can provide evidence for their expectation that p is false, as in the neutral scenario in (27). This account derives the bias reversal that is present with *mica*.

Recall that *mica* does not license NIs, and does not anti-license PPIs. This was puzzling on the Frana and Rawlins (2013) double-negation account, but follows directly on this proposal. While *mica* introduces a negative element, FALSUM does not license NPIs or anti-license PPIs, as it is the wrong sort of negative element, and so the prediction is that *mica* questions will behave exactly the same as outer-reading NPQs in terms of licensing.

A closely related puzzle is that Mica-PQs pattern like PPQs with respect to answer particles. That is, *si* and *no* pick out the 'positive' and the 'negative' answer respectively as if the question were a PPQ. While there are several accounts of answer particles on the market (see also Krifka 2013, Farkas and Roelofsen 2015), the facts follow from this proposal about *mica* on all of them. Here we focus on Kramer and Rawlins (2009). On that proposal, answer particles license surface anaphora (ellipsis) anteceded by a TP in a prior utterance. Because the antecedent TP on a *mica* question does not have any negative element, we expect the same behavior as with positive questions (a prediction noted also by Kramer and Rawlins 2009 for English NPQs on the outer reading).

6.2. Returning to 'mica' in assertions

Cinque (1976) (see also Zanuttini (1997), Penello and Pescarini (2008), Pescarini (2009)) suggest that *mica* is a presupposition trigger: a sentence of the form *(non) mica* p asserts that $\neg p$ and presupposes that p was expected. Our goal here is to capture the core insight of this idea, while providing a proposal that can account for the wider range of data and unify assertions and polar questions. The proposal we have made for *mica* questions straightforwardly makes a prediction for assertions. *mica* should signal a speaker-oriented denial via FALSUM_{s_c, s_c}.

This proposal directly captures the facts we have introduced about *mica* in assertions. First, its licensing conditions – *mica* in an assertion requires a salient expectation to deny. As with polar questions, a FALSUM assertion is meta-conversational, and leads to Economy-based inferences about why the speaker would choose to make a meta-conversational move, e.g. a quality dilemma. In denial contexts in particular, the speaker indicates an epistemic conflict. Therefore, a *mica* assertion will imply that the context provide some salient claim or expectation that p for the *mica* assertion to deny. If there is no such salient expectation, then the utterance will be a violation of the Economy principle. As with R&H's epistemic inferences, this kind of inference is not cancelable. Second, because *mica* introduces a CG-management operator, we predict that its LF scope will necessarily be high in the left periphery, thus leading to the prediction that it should outscope modals.

Finally, this proposal captures the parallels between *mica* questions and assertions. In both cases, *mica* introduces a speaker-oriented FALSUM operator. The perspectival stability of *mica* is masked in assertions, but makes itself known in polar questions. The result of this stability for NPQs is to invert the R&H pragmatic logic, resulting in a reversed bias from regular NPQs, but in assertions *mica* simply looks like a strong negative particle.

While this account does not involve the presupposition that p is expected, it derives a very similar inference using the Economy principle, given the strong negative semantics of FALSUM, at the same time explaining the intuition that *mica* assertions are used as denials. The account thus preserves Cinque's intuition, but derives it in a very different form.

7. Conclusions

We have provided a new account of the Italian negative particle *mica* as a perspectivally anchored Common Ground management operator (Romero and Han 2004, Repp 2013, Romero 2014), based on Repp's meta-conversational negation operator FALSUM. This accounts for (i) its use in assertions to indicate denial, and (ii) its use in polar questions to signal that the speaker had some prior expectation that the prejacent is false, as well as (iii) bias reversal between negative and *mica* polar questions: the CG-management content is the same in each, but anchored to the hearer for NPQs and with a mixed (hearer/speaker) anchor for for *mica* questions, leading to inverted pragmatic inferences. In both assertions and polar questions, the reasoning is centered around Romero & Han's

Economy principle: using a meta-conversational form leads to inferences about how the speaker intends to resolve a dilemma about the maxim of quality; either there is some epistemic conflict, or some missing evidence. Along the way we demonstrated that Italian negative polar questions, despite a single position for negation, show Ladd's ambiguity between inner and outer readings.

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Good manners: On the degree effect of good events[1]

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Abstract. This paper discusses the semantics of so-called 'degree' *well* in English and German, in examples such as *well loaded* and *gut beladen*. While in previous literature *well* is analysed as an ad-adjectival modifier (of closed scale adjectives), we propose to examine *well* as a manner adverb and to derive the manner vs. degree reading from the type of event *well* is a predicate of.

Keywords: modification, manner, degree, event, adverb.

1. Introduction

The adverb *well* across languages (henceforth WELL) has been ascribed two readings, a manner and a 'degree' reading (1), paraphrasable as 'in a good manner' and 'to a good degree', respectively.

(1)   a.   He has written the article well.   MANNER
         b.   They are well acquainted.   'DEGREE'

Manner WELL seems to be uniformly available and has been treated as an event predicate in the verbal domain. 'Degree' WELL, on the other hand, is not a uniform phenomenon. The examples to illustrate English 'degree' *well* generally involve participles, as in (1b) (e.g. Bolinger, 1972; Kennedy and McNally, 2005; McNally and Kennedy, 2013). In (standard) English, it is usually not possible to use *well* as a degree modifier of genuine adjectives (2a) (unlike degree modifiers like *very*, etc.); similarly for German (2b).

(2)   a.   *The train is well blue / long / beautiful.
         b.   *Der Zug ist gut blau / lang / schön.
            the   train is well blue   long   beautiful

In Catalan, on the other hand, this is possible (3) (cf. González-Rodríguez, 2006; Hernanz, 2010; González-Rivera and Gutiérrez-Rexach, 2012, for similar data from different varieties of Spanish).

(3)   El tren és ben blau / llarg / bonic.
      the train is well blue   long   beautiful
      'The train is very / rather / quite blue / long / beautiful.'

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Based on data like these, we argue in Castroviejo and Gehrke (2015) that degree WELL comprises at least two different phenomena. On the one hand, we have a (degree-)'intensifying' WELL, which is absent in English and German, but present in Catalan and Spanish. In that paper we show that Catalan WELL has similar uses as other degree modifiers (cf. translation of (3)), and we propose that intensifying WELL expresses the speaker's approval of a property ascription.

On the other hand, we have English and German 'degree' WELL (scare quotes are meant to indicate that degree effects are just an indirect result of predicating goodness of certain events, under conditions to be spelled out in what follows), which we labeled 'manner-in-disguise' WELL in that paper, and which is the main focus of the present paper. We will argue that English and German WELL is not an adjectival degree modifier, but exclusively a VP modifier, i.e. a predicate of events (in the broadest sense, to include states). We will show that whether or not a 'degree' reading is available depends entirely on properties of the underlying verb.

The paper is structured as follows. In §2, we outline what McNally and Kennedy (2013) say about the restrictions on 'degree' WELL, their scalar account, and the problems we see with it. In §3 we change the perspective from the adjectival to the verbal domain and make more precise the conditions under which a 'degree' reading arises, by taking a closer look at German, which seems to behave like English. In §4 we outline different options to account for the 'degree' reading of the verbal modifier WELL, which all, however, face some drawbacks. Finally, §5 concludes.

2. 'Degree' *well* in English

In this section, we summarize what McNally and Kennedy (2013) (McN&K) say about 'degree' *well* in English (see also Kennedy and McNally, 1999, 2005). McN&K note that 'degree' *well* is possible with past participles, but usually not with genuine adjectives (recall (2)).[2] Furthermore, they posit three conditions on the 'degree' interpretation of *well*. First, it requires a gradable adjective (i.e. adjectivized past participle). Second, it requires a totally closed scale, diagnosed by modifiability by *partially/fully* (4).

(4)   a. The truck is well / partially / fully loaded.

        b. ??Marge was well / partially / fully worried when she saw the flying pig.

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[2]Kennedy and McNally (2005, 375) provide the following examples for 'genuine' adjectives with 'degree' *well*:

(1)   a. We are well aware of the difficulties.

        b. They are well able to solve their own problems.

        c. The bud was well open.   (Bolinger, 1972, 43)

We are not sure that (1a) and (1b) should be treated as genuine adjectives, whereas (1c) clearly seems to be one; similar marginal cases also exist in German. We leave such cases for future research.

Third, the standard of comparison cannot be the maximum, given the assumption that 'degree' *well* boosts the standard. For example, the sentences in (5) allow for both a manner and a 'degree' reading of *well*, whereas those in (6) only have a manner reading.

(5)   a. They are well acquainted.   'DEGREE'/MANNER
            b. The truck is well loaded.

(6)   a. The book is well written.   ONLY MANNER
            b. The hay is well loaded.

McN&K assume that the standard with deverbal adjectives is determined by the scale structure derived from the event/argument structure of the underlying verb. In particular, they argue that, when the argument is an incremental theme, as in (6), what counts as a loaded/written incremental theme can only be such that the maximum standard is met, i.e. it is completely loaded/written. Cases like these can only have a manner reading. With other arguments (e.g. (5)), the standard is not necessarily the maximum, i.e. a truck can also be partially loaded, and a 'degree' reading is available. Thus, the 'degree' interpretation is possible only if the argument of the modified participle is a non-incremental theme argument of the source verb.

They also argue that 'degree' *well* cannot be a true degree modifier. Given the assumption that degree modification binds off the degree argument, true degree modification does not allow additional degree modification (7a); however, 'degree' *well* does (7b).

(7)   a. *{completely very / very completely} red
            b. very well acquainted

The general idea of McN&K's analysis goes as follows. Informally, it is stated that 'degree' *well* is a special case of manner *well*, since both apply to events. Furthermore, it is argued to denote a measure function on events, and in an HPSG representation, *well*'s restriction is encoded as a relation between an event and a degree. This measure function is assumed to be the same as that denoted by the adjective *good*: it maps an event onto a(n open) scale of goodness. Finally, they build the scale structure requirements observed in (4) directly into the lexical semantics of 'degree' *well*. While we agree with the first steps of this account, we will take issue with its last point.

For the lexical representation of *well* in (8), McN&K employ the Generative Lexicon and the HPSG frameworks, but in Kennedy and McNally (2005), they provide essentially the same account, now couched within a formal semantic approach to the scale structure of adjectives. In particular, they propose that 'degree' *well* requires a closed-scale adjective as its input (represented by [0,1]) and returns a new gradable adjective meaning based on the relative adjective *good* (8).

(8) $[\![\text{well}]\!] = \lambda G_{[0,1]} \lambda d \lambda x . \textbf{good}(\epsilon(\iota d'[G_{[0,1]}(d')(x)])) = d$

The derived predicate is taken to measure the goodness of the event that is related to the degree to which the subject has the property named by the adjective. With deverbal adjectives, then, the degree is that to which the object possesses the relevant property as a result of participating in the event. This event of x becoming G is formulated as $\epsilon(\iota d'[G_{[0,1]}(d')(x)])$ in (8).

To account for the difference between 'degree' and manner *well*, McN&K propose that participles come with a telic and an agentive quale (in the sense of Pustejovsky, 1995). Under the manner reading, then, *well* applies to the event in the agentive quale, via selective binding, which leads to the assignment of a value on the goodness scale to the process of the event. Under the 'degree' reading, in turn, *well* applies to the event in the telic quale and thus a goodness value is assigned to the result state. For example, for our initial *loaded-with* (5b) vs. *loaded-on* (6b) cases, McN&K assume two different lexical entries where only the former comes with a closed-scale structure of loadedness (see op.cit. for the formalization). A state of being *loaded with* something, then, they state, can truthfully obtain as soon as the smallest loading event has occurred. Thus, there are result states of different degrees of loadedness that can be qualified with respect to the goodness scale and a 'degree' reading can be obtained. A state of being *loaded on* some container, however, which is what happens with incremental themes, will only truthfully obtain when the loading has been completed. All result states are therefore assumed to be identical in degree and it does not make sense to try to qualify them with respect to the goodness scale.

We see at least one major problem with this account. Even though McN&K aim at deriving the degree reading from the manner reading, they do not do that, as they actually do not provide an account of manner *well*. The only thing that 'degree' and manner *well* have in common is that they denote properties of events, which is what is stated in prose rather than shown formally. However, since McN&K build the scale structure conditions above directly into the lexical semantics of 'degree' *well*, they have a lexical entry for 'degree' *well* only, and it is not clear how or if this *well* can be related to manner *well*.

Thus, we take issue with building scale structure considerations relevant in the adjectival domain into the lexical semantics of an essentially verbal modifier. However, we will use the other ingredients of McN&K's account: 'degree' WELL is a special case of manner WELL, both rely on a measure function on events, and this measure function is the same as that denoted by the adjective *good*. In order to arrive at a clearer picture about the restriction on the 'degree' reading of the verbal modifier WELL, we now change the perspective and look at the verbal domain.

3. 'Degree' vs. manner WELL in German

In order to investigate the restriction on the 'degree' reading of WELL in the verbal domain, we switch to German, which seems to behave like the English examples discussed in the papers by Kennedy and McNally. For example, the German counterpart to their 'closed-scale adjective'

(again, this has to be read as 'adjectival participle') *loaded* (if it is the truck that is loaded) is compatible with proportional modifiers and 'degree' WELL (9a), and additional true degree modification is possible (9b); participles like *geschlossen* 'closed' behave the same.

(9) a. Der Lastwagen ist {halb / gut}   beladen.
         the truck   is half   WELL AT-loaded
         'The truck is half / well loaded.'

     b. Der Lastwagen ist {sehr / ziemlich} gut   beladen.
         the truck   is very   rather   WELL AT-loaded
         'The truck is {very / rather / not} well loaded.'

With incremental themes, on the other hand, as in the case of *gut geschrieben* 'well written' or hay being well loaded (10), the 'degree' reading is not available.

(10) Das Heu ist gut   geladen.   ONLY MANNER
      the hay is WELL loaded

However, we have some doubts about McN&K's generalizations which were couched entirely in an adjectival perspective. First, a closed scale does not seem to be sufficient for the 'degree' reading to arise. In particular, some participles that allow modification by proportional modifiers like *partially* (11a), and thus behave like closed-scale adjectives according to McN&K, nevertheless do not give rise to the 'degree' reading (11b).

(11) a. Die Tür ist {teilweise / halb / ganz} geöffnet.
          the door is partially   half   whole opened
          'The door is {partially / half / totally} opened.'

      b. Die Tür ist gut   geöffnet.   ONLY MANNER
          the door is WELL opened

Furthermore, participles derived from incremental theme verbs are compatible with proportional modifiers in both languages (illustrated in (12) for English), making available a quantity scale associated with the incremental theme (see Caudal and Nicolas, 2005, for a differentiation between quantity and intensity scales), and this is also the case with both instances of *loaded*.

(12) a. The book is partially written. ∼ Part of the book is written.

      b. The hay/truck is partially loaded. ∼ Part of the hay/truck is loaded.

So again, if proportional modifiers diagnose a closed scale and this were all we needed for the 'degree' reading to arise, it should arise with all incremental theme verbs as well, but it does not.

The second worry is about McN&K's general treatment of incremental theme verbs. Recently, it has been argued convincingly that such verbs by themselves do not provide a unidimensional scale to measure out the event but are simple activity verbs, or manner verbs (as opposed to result verbs), in the terminology of Rappaport Hovav and Levin (2010). For example, Kennedy (2012) himself argues that an incremental theme can be added to such non-scalar verbs to add a scale to measure out the event. However, WELL does not modify the theme but only the participle, so the participle alone cannot provide a closed scale for 'degree' WELL to apply to.[3] Under their account, this means that such verbs do not have a result state in their lexical representation (= no telic quale), but denote an activity only (= have an agentive quale). This is different for the *loaded-with* cases, which in German already come with a prefix *be-* (cf. (9a)) and are thus arguably already lexically marked for resultativity (and thus for a maximum on a scale, if you will).

Additional support for the absence of a result state in the lexical representation of these verbs comes from the fact that, out of context, they are not good inputs to adjectival passivization, precisely because they lack a stative component (13) (cf. Gehrke, 2015, and literature cited therein). Additional manner modification (in this case WELL) can render the adjectival passive construction acceptable again, but without it it can only have a 'job-is-done' reading (in the sense of Kratzer, 2000).

(13)   Das Buch ist ?(gut) geschrieben.
       the   book is   well   written

Thus, we conclude that the underlying incremental verbs only have a process (activity component) for WELL to measure. This alone accounts for the unavailability of the 'degree' reading, and we do not have to resort to the investigation of open vs. closed scales.

Let us then change the perspective and ask which verbs are compatible with 'degree' WELL. The restrictions on the 'degree' reading of WELL are essentially the same in the verbal domain. To show this we will employ examples with verbal participles, which in German are formally distinct from adjectival ones. In particular, while adjectival participles combine with the copula *sein* 'be', verbal participles combine with the auxiliary *werden* 'become' (cf. Gehrke, 2015, and literature cited therein). In (14a), then, we see that WELL can have both a 'degree' and a manner reading, whereas in (14b) it only has a manner reading.

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[3]With adjectival participles, the theme argument itself behaves like an external argument, i.e. is externalized at some point (cf. McIntyre, 2013; Bruening, 2014, and literature cited therein), so WELL clearly cannot access the verb and the theme argument together.

(14) a. Der Lastwagen wurde gut   beladen.   'DEGREE'/MANNER
         the truck   became WELL AT-loaded
         'The truck has been well loaded.'

      b. Das Heu wurde gut   geladen.   ONLY MANNER
         the hay became WELL loaded
         'The hay has been loaded well.'

What, then, are the restrictions on both readings? First, we know that manner adverbs require eventive verbs (cf. Katz, 2003; Maienborn, 2005; Mittwoch, 2005, i.a.), so stative verbs should allow at most a 'degree' reading. In the following we investigate three hypotheses about the availability of the 'degree' reading. First, we ask whether we need a stative component in the lexical representation of the verb, i.e. a state, a result state, or a 'target state' (in the sense of Parsons, 1990; Kratzer, 2000). Second, we investigate whether we need a (potential) lack of agentivity, and third, whether we need a high degree of affectedness. We will see that while all these conditions are necessary they are not by themselves sufficient for the 'degree' reading of WELL to arise.

3.1. Do we need a (result) state?

In (15), we see that even verbs that do not derive adjectival passives allow for a 'degree' reading, namely stative verbs, for which this is the only possible reading.

(15)   a. Sie kennen einander   gut.   ONLY 'DEGREE'
          they know   each other WELL

       b. Sie passen gut   zusammen.
          they fit   WELL together.

However, not all verbs with stative components allow for 'degree' WELL; cf. (11b), and its verbal counterpart in (16a). Stative object experiencer predicates like those in (16b) do not allow for WELL at all, whereas their verbal passive counterparts in combination with WELL can only have an agentive reading and WELL applies to the manner, as in (16c).

(16)   a. Die Tür wurde gut   geöffnet.   ONLY MANNER
          the door became WELL opened

       b. *Er war gut   gelangweilt / überrascht.
          he was WELL bored   surprised

       c. Er wurde gut   gelangweilt / überrascht.   ONLY MANNER
          he became WELL bored   surprised

This is not due to the alleged scale structure conditions of McN&K, given that both types of adjectival participles are compatible with proportional modifiers; cf. (11a) and (17).

(17) Er war {teilweise / halb / ganz} gelangweilt / überrascht.
      he was partially   half   whole bored   surprised

This could be a blocking effect, given that we have alternative means to express something like a 'degree' reading with these adjectival participles, such as *sehr gelangweilt / überrascht* 'very bored / surprised' and *weit geöffnet* 'wide(ly) opened'. Alternatively, we could assume at least for the participles in (17) that they are directly derived from the verbal root and thus do not contain a VP (cf. lexical adjectivization in Kratzer, 2000). With these adjectival participles, then, adverbial modifiers (like WELL) would not be able to access a VP but only the AP. This, however, is not possible in languages like German, as we have already seen in (2). In Catalan, on the other hand, it is possible, and we only get an intensifying reading (see Castroviejo and Gehrke, 2015).

In sum, while a stative component seems to be a necessary condition for the 'degree' reading to arise, it is not sufficient.

3.2. Do we need a (potential) lack of agentivity?

In (18), we see that necessarily agentive verbs (in the sense that they necessarily come with an external argument in control of the event) do not allow for the 'degree' reading.

(18) a. Er tötet gut.   ONLY MANNER
         he kills WELL

      b. Sie ist gut   in den   Baum geklettert.
         she is WELL in the.ACC tree   climbed
         'She has climbed into the tree well.'

Thus, we could speculate whether the unavailability of a 'degree' reading might be due to the fact that the activity/volitional component of these verb(use)s cannot be absent; they are necessarily agentive. For example, there seems to be a partial correlation with whether or not a verb can participate in the causative-inchoative alternation (19).

(19) a. Die Tür schließt sich.
         the door closes   SELF
         'The door closes / is closing.'

b. *Das Buch schreibt sich.

the   book   writes   SELF

Intended: 'The book writes / is writing.'

c. #Er tötet sich.

he   kills   SELF

(Only reflexive: 'He kills himself.')

It has been proposed that the inchoative version of this alternation involves the suppression of a cause argument, so that verbs which are specified for agents rather than causes as external arguments cannot participate in this alternation (cf. Siloni, to appear, and literature cited therein).

However, the correlation is not perfect. One of our problematic cases from the previous section is also a problematic case here, since a predicate like *open* participates in the causative-inchoative alternation (20) but only allows for the manner reading (with either adjectival or verbal participles; recall (11b) and (16a)).

(20)   Die Tür   öffnet sich.

the door opens SELF

'The door opens / is opening.'

Thus, a potential lack of agentivity may be a necessary but, again, not sufficient condition for the 'degree' reading of WELL to arise.

3.3. Do we need a high degree of affectedness?

Finally, we explore the question whether the 'degree' reading requires a high degree of affectedness. The hunch that affectedness might also play a role comes from the fact that the German counterpart to the alternation we find with *load* in English, which correlates with whether or not we can get a 'degree' reading for WELL, employs different verb(form)s. In particular, the 'degree' reading is only available when the verb is prefixed by *be-* (as in *beladen*; cf. (9)), which has also been described as a prefix expressing affectedness.

Beavers (2011) posits the 'Affectedness Hierarchy' in (21), with x, s, g, and ϕ as variables over themes, scales, end states, and predicates, respectively, and with $\mathbf{g}_\phi$ expressing the target state of a given predicate ϕ.

(21)   **The Affectedness Hierarchy**: for all x, ϕ, e,

$\exists s[result'(x, s, \mathbf{g}_\phi, e)]$ (quantized change)

$$\rightarrow \exists s \exists g[result'(x, s, g, e)] \quad \text{(non-quantized change)}$$
$$\rightarrow \exists s \exists \Theta[\Theta(x, s, e)] \quad \text{(potential for change)}$$
$$\rightarrow \exists \Theta'[\Theta'(x, e)] \quad \text{(unsecified for change)}$$

This hierarchy, then, goes from predicates that are specified for what he calls 'quantized change' and thus involve the highest degree of affectedness (roughly, predicates lexically specified for a target state, i.e. accomplishment and achievements), to predicates that are unspecified for change (they lack a scale altogether) and thus involve the lowest or no degree of affectedness. His examples for the predicates in question are given in (22).

(22) a. Quantized change: *break, shatter, destroy, devour x*

b. Non-quantized change: degree achievement, e.g. *widen, cool, lengthen, cut, slice x*

c. Potential for change: *wipe, scrub, rub, punch, hit, kick, slap x*

d. Unspecified for change: *see, laugh at, smell, follow, ponder, ogle x*

As diagnostics for these properties he discusses the following. First, only his 'quantized' predicates behave like telic predicates. Second, the entailment that the theme underwent some change is only found with quantized and non-quantized predicates, but not with the others. Third, only quantized, non-quantized, and some predicates specified for potential change take result phrases. Fourth, paraphrases with 'happened/did to x' are available only with predicates specified for quantized, non-quantized, and potential change. Fifth, predicates specified for quantized, non-quantized, and potential for change, as well as some that are unspecified for change, are dynamic. Finally, there is a high variation of different resultatives added with those predicates that are specified for a potential for change, but low with those specified for quantized and non-quantized change.

While we do not want to make any theoretical claims about what affectedness is, we merely use the German counterparts to the English examples discussed by Beavers to see how they fare with respect to the availability of the 'degree' reading of WELL. First, in (23), we see that the counterparts to his 'quantized' predicates can have both a 'degree' and a manner reading.

(23) a. Die Vase ist gut zersplittert.   'DEGREE'/MANNER
         the vase is well shattered

b. Das Gebäude ist gut zerstört.
         the building is well destroyed

Beavers also counts verbs of breaking under this category. However, confirming our hunch from the previous section about the necessary potential lack of agentivity, we see that uses of *break* that do not have inchoative variants also do not allow for the degree reading (24).

(24)   Das Brot ist gut gebrochen.   ONLY MANNER
       the bread is well broken

Beavers posits non-quantized change in particular for degree achievements. In (25) we see that
also these allow for both readings.

(25)   a. Der Wein ist gut gekühlt.   'DEGREE'/MANNER
          the wine is well cooled

       b. Die Hose   ist gut gekürzt.
          the trousers is well shortened

In addition, he posits non-quantized change also for verbs of cutting. In (26), we see that such
verbs only allow for the manner reading of WELL, whether they are prefixed or not. This could
again be due to the fact that they also cannot lack external arguments (e.g. they do not have an
inchoative version).

(26)   a. Das Holz ist gut geschnitten.   ONLY MANNER
          the wood is well cut

       b. Das Band ist gut durchgeschnitten.
          the ribbon is well THROUGH-cut

Third, predicates with a potential for change only allow for the manner reading of WELL (27).

(27)   Der Tisch ist gut   gewischt.
       the table is well wiped

Finally, verbs that are unspecified for change do not form adjectival passives and are thus unac-
ceptable with or without WELL in the adjectival passive (28a), (29a). In verbal constructions, in
turn, combinations of these verbs with WELL express something like a good degree of V-ability
(28b), (29b).

(28)   a. *Die Frau   ist (gut) gesehen.
          the   woman is well seen

       b. Hans hat die Frau   gut gesehen.
          John has the woman well seen

          'The woman was well visible to John.'

(29)   a.   *Die Blume ist (gut) gerochen.
           the   flower is well smelled

        b.   Hans hat die Blume gut   gerochen.
           John has the flower well smelled
           'John could smell the flower well.'

We do not have an explanation for this additional modal component with these predicates and have to leave it for future research. What these data show, then, is that a high degree of affectedness may be a necessary but not a sufficient condition for the 'degree' reading of WELL to arise.

3.4. Summary

In sum, whether or not we get a 'degree' reading of WELL depends entirely on the nature of the event denoted by the (underlying) verb and we do not have to posit scale structure conditions as those found in the adjectival domain. Thus, 'degree' WELL is an adverbial modifier in the verbal domain, not an adjectival degree modifier. Our preliminary empirical results suggest that there are three necessary but not sufficient conditions for the 'degree' reading to arise: stativity, potential lack of agentivity, high degree of affectedness.

Let us then turn to different possibilities for how to account for the two readings of WELL in the verbal domain.

4. Towards a proposal

The general idea of our proposal is that both manner and 'degree' WELL involve event modifying WELL and that the difference between them results from the different kinds of events that are modified (for an extension to Catalan intensifying WELL see Castroviejo and Gehrke, 2015). The adverb WELL is a VP modifier that has the same lexical semantics as the underlying adjective *good* (approval by some judge) (inspired by the prose in McNally and Kennedy, 2013). We follow the degree approach to gradable adjectives (e.g. Kennedy and McNally, 2005) and treat **good** as a measure function, which maps individuals to degrees on a scale (30a). Combining this with the standard treatment of manner modifiers (= VP modifiers) as predicates of events (e.g. Parsons, 1990), we get the semantics of WELL in (30b).

(30)   a. $[\![\text{good}]\!] = \lambda d.\lambda x[\mathbf{good}(x) \geq d]$
        b. $[\![\text{well}]\!] = \lambda d.\lambda e[\mathbf{good}(e) \geq d]$

In the absence of additional degree morphology, d gets bound by POS, which determines the standard with respect to some comparison class, as commonly assumed in degree approaches to grad-

ability; we will abstract away from this in the following.

The manner reading of WELL is available with all verbs that allow for manner modification. These are usually all verbs that have an activity/process component, whereas many stative verbs do not allow manner modification, as noted in §3. Nevertheless we assume that also states have an event argument and that the reduced availability of manner modification with states is due to their being conceptually poorer; see, e.g., Mittwoch (2005); Geuder (2006).

There are different options for how to account for the 'degree' reading, and none of these is fully satisfactory as we will see in the following. Adverbs with a similar reading have been discussed in the literature under different labels. For example, Eckardt (1998) subsumes WELL under her 'degree-of-perfection' adverbs, which also include adverbs like *perfectly, beautifully, badly* (31) (from Eckardt, 1998, 160).

(31) a. Olga spielte die Sonate perfekt.
          Olga played the sonata perfectly
          'Olga played the sonata perfectly.'
      b. Paul hat den Handstand mittelgut   ausgeführt.
          Paul has the handstand middle-well executed
          'Paul executed the handstand sub optimally.'
      c. Tim baute das Zelt schlampig auf.
          Tim built the tent sloppily   up
          'Tim built the tent sloppily.'

Schäfer (2005) argues, very much like us, that these are a special case of manner adverbs, whereas Piñón (2008) suggests that these are possibly semantic blends of manner and result.

Adverbs like *beautifully, heavily*, and *elegantly*, which are labeled 'resultative' (Geuder, 2000) or 'result-oriented' (Eckardt, 2003), also have similar readings (32) (from Geuder, 2000, 69).

(32) a. They decorated the room beautifully.
      b. She dressed elegantly.
      c. They loaded the cart heavily.

Geuder (2000) discusses three different analyses of such adverbs, which all treat them as predicates of events. First, they could involve the modification of the event in the telic quale of the verb (Pustejovsky, 1995), second they could involve result state modification (e.g. Parsons, 1990), and third, they could involve some kind of predicate transfer (in the sense of Nunberg, 1995), a proposal that Geuder (2000) opts for in the end. We have already seen an implementation of the first type

when we addressed the proposal by McNally and Kennedy (2013), so in the following, we will only discuss the other two types of analyses. We will see that both face some problems and end up with proposing an unfortunately weaker account in terms of underspecification.

4.1. The event decomposition option

We could follow a common implementation of event decomposition in terms of VP shells. When WELL modifies a VP that is associated with an activity/CAUSE we get a manner reading. When WELL modifies a VP that is associated with a (result) state, we get the 'degree' reading. Note that empirically this could be a syntactic implementation of McNally and Kennedy's (2013) account in terms of modification of different qualia, which we outlined in §2. For example, Parsons's (1990) analysis of 'open wide' is given in (33), and we could employ a similar account for 'degree' WELL.

(33) $(\exists e)[\mathbf{Cul}(e) \wedge \mathbf{Agent}(e, x) \wedge (\exists e')[\mathbf{Cul}(e') \wedge \mathbf{Theme}(e', y) \wedge \text{CAUSE}(e, e') \wedge (\exists s)[\mathbf{open}(s) \wedge \mathbf{Theme}(s, y) \wedge \mathbf{Hold}(s) \wedge \text{BECOME}(e', s) \wedge \mathbf{Being\text{-}wide}(s)]]]$

A possible argument for this account goes as follows. Eckardt (2003) shows that in verb-final clauses, German result-oriented adverbs have to appear after the direct object (34), whereas manner adverbs can appear either before or after the direct object.

(34)   ... (dass) Hans {*schwer} den/einen Wagen   {schwer} belud.
          that) Hans heavily   the/a   carriage heavily   AT-loaded
       '... (that) Hans loaded the carriage heavily.'

German WELL, then, gets the 'degree' reading only in the lower position (35), which suggests that there is a structural difference between the two readings of WELL.

(35) a. ... (dass) Hans gut den/einen Wagen belud.   ONLY MANNER
             that) Hans well the/a   carriage AT-loaded
          '... (that) Hans loaded the carriage well.'
      b. ... (dass) Hans den/einen Wagen gut belud.   'DEGREE'/MANNER
             that) Hans the/a   carriage well AT-loaded
          '... (that) Hans loaded the carriage well.'

However, a problem for the event decomposition option is that clear cases of bi-eventives, such as *open* (cause x to become open) or *kill* (cause x to become dead) only allow for the manner reading

(recall (11b)/(16a) and (18a)). In the latter case, we could still wonder whether this is due to the fact that the causative/agentive component of a verb cannot be left out, but this cannot be the reason for *open*. On the other hand, we could ask then, whether this is just another point that shows that verbs like *kill* should not be decomposed in the syntax? However, then it is not clear why other adverbs, such as *again* (e.g. von Stechow, 1996), can access result states with such verbs as long as they have reversible result states, as in the case of *open*. All these considerations shed serious doubt on the event decomposition approach to 'degree' WELL.

4.2. The predicate transfer option

Under Geuder's (2000) treatment of resultative adverbs as event modifiers, the verbs which allow such readings are argued to have resultant individuals as implicit (semantic but not syntactic) arguments, as paraphrased in (36).

(36) a. They decorated the room beautifully. → beautiful decoration
      b. She dressed elegantly. → elegant dress
      c. They loaded the cart heavily. → heavy load
      d. She wrapped the gift nicely. → nice wrapping

For example, his lexical entry of *load* is given in (37). By predicate transfer, instances of event modification, such as those in (36), are turned into indirect modification of resultant individuals.

(37) a. Semantic arguments: AGENT, THEME, LOCATION, RES(ultant)-I(ndividual)
         $load(e)(a, x, y, r)$
      b. Lexical entailments:
         → a CAUSE (BECOME (AT $(x, f_{\text{LOC}}(y))$))
         & $R(r, y)$, such that
         - it presupposes BECOME (AT $(x, f_{\text{LOC}}(y))$)
         - y specifies a function for r [roughly: "transport"]
         & CONSTITUTE(x, r) [here: r is a collective object with x-individuals as parts]

A problem for adopting this account for our purposes is that the 'degree' reading of WELL does not arise in the same environments as the result reading of other adverbs does. For example, in (38a), we might get something like a 'degree' reading (all these verbs are also prefixed), but in (38b) we definitely only get a manner reading (and none of these verbs are prefixed).[4]

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[4]Unlike the other data reported in this paper, these data have not been checked with other native speakers but only reflect the already shaky judgments of one of the authors, which is why we opted for adding question marks behind the labels ('DEG'/)MANNER.

(38)   a. gut   beladen/verpackt/eingewickelt   'DEGREE'/MANNER?
            well AT-loaded/PREF-packed/IN-wrapped

       b. gut   geschmückt/gekleidet   ONLY MANNER?
            well decorated/dressed

On the other hand, the respective paraphrases with nominalizations might still hold (39).

(39)   a. gut   beladen/verpackt   → gute Ladung/Verpackung
            well AT-loaded/PREF-packed   good load/packaging

       b. gut   geschmückt/gekleidet → guter Schmuck/gutes Kleid
            well decorated/dressed   good decoration/good dress

So we might still be dealing with implicit arguments that are modified by predicate transfer, only we do not always get a 'degree' reading. But then we have not accounted for the restrictions on the 'degree' reading either, other than observing for these six verbs that there is also a difference whether or not they are prefixed; from previous examples we see that a prefix is not a necessary condition for the 'degree' reading to arise, though. Faced with these problems, we discard also this account and opt for a weaker one in terms of underspecification, as outlined in the following.

4.3. The underspecification option

One possible way to implement an underspecification account is to posit that context fills in the additional information that is not specified and thus determines which reading we are dealing with. However, this can clearly not be right for our cases, since the restrictions have to do with the lexical semantics of the verbs involved and context does not seem to play a role. Nevertheless, we opt for an underspecification account to remain agnostic as to the precise implementation of the restrictions on 'degree' WELL.

For an implementation in terms of underspecification, we follow Schäfer (2008), who builds on Eckardt's (1998) notion of a 'big event' e^*, a complex event consisting of smaller event objects (introduced by the **PART_OF**-relation). Abstracting away from the degree argument and from Tense, **good**, then, accesses either the big event or part of the event, as illustrated for (14a) in (40).

(40) $\exists e^*, x[\textbf{subject}(x, e^*) \wedge \textbf{object}(\textbf{the-cart}, e^*) \wedge \exists e[\textbf{PART\_OF}(e, e^*) \wedge \textbf{load}(e) \wedge \textbf{good}(e/e^*)]]$

If it accesses the big event, we get the manner reading, but if it accesses just part of the event, a 'degree' reading is possible. Alternatively, we could always have it modify part of the event, and then it is underspecified as to which part exactly (the process or the result).

5. Conclusion

We have elaborated on and qualified McNally and Kennedy's (2013) claim that 'degree' WELL is an event modifier by examining its distribution in (English and) German. We argue that both manner and 'degree' readings of WELL share a common semantic core: the measure function **good** is applied to an event. We have shown that the 'degree' reading arises when WELL applies to a (result) state of a non-agentive event that selects a highly affected argument, and we sketched different options of how to formally account for this reading, none of which were fully satisfactory.

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Theta-head binding in the German locative alternation[1]

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Abstract. In this paper, we analyze the locative alternation of the *spray/load*-type with *be*-prefixation in German on the basis of the analysis of free datives proposed in Hole (2008, 2012, 2014). We argue that both structures involve obligatory variable binding in a local domain, triggered by a functional theta head. The core of our analysis elaborates upon Kratzer's (2009) proposal to implement reflexivity in an agent-severed system. According to this proposal, binder indices are tied to verbal functional heads (theta heads) instead of so-called antecedent DPs.

Keywords: theta head, local binding, locative alternation, argument alternation

1. Introduction

It is well known that in German, as well as in English, possessive pronouns can be used anaphorically, or they can be bound.

(1) *Der Udo zeigte dem Peter seine Tasche.*   (lexical dative)
     the Udo showed the Peter$_{DAT}$ his bag
        (i)   'Udo showed Peter$_i$ his$_i$ bag.'
        (ii)   'Udo$_j$ showed Peter his$_j$ bag.'
        (iii) 'Udo$_i$ showed Peter$_j$ his$_k$ bag.'

However, such an array of options is not available in every construction. In the extra-argumental ("possessor") dative construction in German (henceforth "free dative"), the binding possibilities are more restricted. Free datives obligatorily bind a possessor variable in a local domain. The possessive-marked DPs alternate freely with Bound Bridging Definites.[2]

(2) *Der Udo trat dem Ede gegen sein/das Schienbein.*   (free dative)
     the Udo kicked the Ede$_{DAT}$ against his/the shin
        (i) 'Udo kicked Ede$_j$ in his$_j$/the$_j$ shin.'
        (ii) *'Udo$_j$ kicked Ede in his$_j$/the$_j$ shin.'
        (iii) *'Udo$_i$ kicked Ede$_j$ in his$_k$/the$_k$ shin.'

[2] Bound Bridging Definites are definite lexical DPs which receive an interpretation equaling (or very similar to) that of the same DP with a possessive pronoun. Crucially, the possessive pronoun in such a paraphrase is locally bound (Hole 2008, 2012, 2014).

A crucial difference between (1) and (2) is that the dative argument in (1) is a lexical argument of the verb, while the dative argument in (2) is an extra argument in an applicative-like construction.

Hole (2008, 2012, 2014) suggests that free datives as in (2), unlike the lexical datives in (1), are introduced by a verbal functional head, or a theta head.[3] Given a proposal made by Kratzer (2009), this verbal functional head ties in well with the fact that free datives always concur with a bound variable further down in the co-phasal structure. According to Kratzer, "semantic binders (λ-operators represented as binder indices) are introduced by verbal functional heads, rather than by "antecedent" DPs, as assumed in Heim and Kratzer (1998), for example. Verbal functional heads, rather than DPs, are then the true syntactic antecedents for bound pronouns" (Kratzer 2009:193). Instead of verbal functional heads, we will speak of theta heads below, in order to refer to heads that introduce a theta role and host a DP in their specifier.

We would like to propose that quite a few syntactic constructions should be analyzed in terms of theta-induced binding (Geist in prep., Hole in prep.). We argue that obligatory binding of co-phasal arguments, as with free datives, also occurs in the *spray/load*-type locative alternation given in (3b), with the base alternant in (3a). In German the locative alternant normally involves prefixation of the verb with the spatial prefix *be-* (henceforth *be*-locative alternation).

(3)   a. *Paula hat Eigelb   auf den Kuchen gestrichen*
          Paula has egg.yolk$_{ACC}$ on the cake   smeared
          'Paula spread egg yolk on the cake.'
      b. *Paula hat den Kuchen mit Eigelb   **be-**strichen*   (*be*-locative alternation)
          Paula has the cake$_{ACC}$ with egg.yolk *be*-smeared
          'Paula coated the cake with egg yolk'

Similar to the free dative construction in (2), the locative alternation construction in (3b), contains a direct object *den Kuchen* 'the cake', which binds a possessor variable in a local domain. The bound variable can *salva veritate* be made explicit as in (3'). Productively prefixed *be*-verbs always involve a bound possessor/whole variable in a PP referring to the neighborhood region OUTSIDE / SURFACE.[4] Curly brackets in (3') indicate material that is, we assume, PF-optional but semantically active, irrespective of whether it is pronounced.

(3')   *den Kuchen$_i$ {an seiner$_i$ Oberfläche} mit Eigelb   **be-**streichen*
       the cake$_{ACC}$ on its   surface   with egg.yolk *be*-smear
       'coat the cake with egg yolk {on its surface}'

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[3] The reasons why Hole doesn't subscribe to a Pylkkänen-style analysis of free datives are laid out in detail in Hole (2012:241-242) and in Hole (2014:295-303).

[4] SURFACE and OUTSIDE are taken here to be instantiations of a single neighborhood region.

We develop an analysis of this construction on the basis of the analysis of free datives (Hole 2012, 2014). The core of our analysis elaborates upon Kratzer's (2009:194) proposal to implement reflexivity in an agent-severed system with theta heads; these heads introduce bare binder indices into the structure. The extension of the proposal beyond free datives (Hole 2014) to the *be*-marked locative alternation forms part of a larger endeavor to demonstrate the necessity of describing many well-known argument alternations as dependent on the presence of binder theta heads.

Although we are using the term "alternation", we do not subscribe to a transformational approach, specifically one that would derive the base alternant and the non-base alternant from the same underlying structure. As pointed out by Levin & Rappaport Hovav (2005:189ff), the lexical entry of the verb captures only its core meaning. This core meaning then can be combined with the event-based meanings represented by syntactic constructions, as proposed in traditional constructional approaches (e.g., Goldberg 1995, Jackendoff 1997, Michaelis & Ruppenhofer 2001). Alternatively, the core verbal meaning can be combined with positions directly in the syntax, as proposed in the so-called neo-constructionist approaches (e.g., Arad 1998, Borer 2003). We subscribe to a neo-constructionist approach, combining a syntactic analysis with an explicit compositional semantics.

The paper is structured as follows: In section 2 we introduce our general theoretical proposal (Hole 2008, 2012, 2014). In Section 3 we apply our theoretical proposal to the *be*-locative alternation in German. Section 4 concludes.

2. Free datives: analysis and implications (Hole 2012, 2014)

2.1. The Landmark theta head with a binder feature

Hole (2008, 2012, 2014) analyzes free datives in (2) in terms of theta heads that license extra arguments, combined with reflexivization as in Kratzer (2009). This is achieved by the mechanism of a binder feature [+b] of the theta head, a mechanism upon which we will elaborate below.

(4)   θP
        /   \
     DP   θ'
            /   \
        θ_{[+b]}   XP
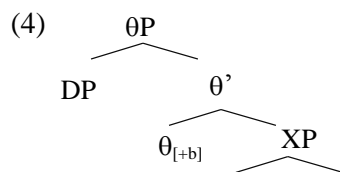
One of the possible thematic contributions of the free dative DP is a locative Landmark entailment, requiring the VP eventuality to hold within the neighborhood regions of the Landmark DP referent. Another possible thematic entailment for free dative referents is the ability to perceive the VP eventuality, an entailment that Hole (2008, 2012, 2014) dubs P-Experiencerhood. Each sentence with a P-Experiencer Dative has at least one contextualized use in which the dative referent has a mental representation of the eventuality in its scope. Hence, for P-Experiencers the ability of the dative referent to perceive the eventuality is

crucial; whereas for Landmarks, the spatial relation, with the eventuality described by its sister node, is crucial. In many cases the Landmark property co-occurs with the P-Experiencer property, as in (5) and (6). However, pure Landmarkhood is also available, cf. (7).

(5) *dem Ede* θ_i *gegen   sein$_i$ / das$_i$ Schienbein treten*   (Landmark (& P-Experiencer))
     the Ede$_{DAT}$ against his/   the   shin   kick
     'kick Ede in the shin'

(6) *jedem* θ_i *streng auf*   sein$_{i/*j}$ /*das$_{i/*j}$ Steak gucken*   (P-Exp (& Landmark))
     everyone$_{DAT}$ strictly on   his   /the   steak look
     'look at everybody's steak in a strict manner'

(7) *Jedem Jungen* θ_i *hängt ein Taschentuch aus   seiner$_i$ / der$_i$ Hose*   (Landmark)
     Every boy$_{DAT}$ hangs a   handkerchief out-of his   / the trousers
     'A handkerchief is hanging out of every boy's trousers'

To preserve perspicuity we will confine our analysis to example (7), where the experiencer entailments are not present. The Landmark theta head θ_{LDM} responsible for the locative entailment has the following simplified semantics (cf. Hole 2012:215 for a more elaborate version):

(8) $[\![\theta_{LDM}]\!] = \lambda y. \lambda s.$ y is the landmark of s

The Landmark theta head is a verbal Voice head much like Kratzer's (1996) (agentive) Voice. The free dative Voice, which always involves binding, turns out to be very similar to run-of-the-mill cases of reflexivity; those must likewise be modeled as triggered by (agentive) Voice (Kratzer 2009), under the theoretical assumptions of Kratzer's (1996) agent severance. The binding property of free datives is particularly striking with Bound Bridging Definites. Binding their implicit possessor variable across clause boundaries is impossible (9), just as between whole sentences (10a). (Anaphoric dependencies are independent of this (10b).) Local binding of Bound Bridging Definites with free datives is obligatory, however; cf. (9) again.

(9) *Klara guckte jedem* θ_i *so streng auf sein$_{i/*j}$/das$_{i/*j}$ Steak, dass   sein$_i$/der$_{*i}$ Appetit verschwand.*
     Klara looked everyone$_{DAT}$ so strictly on his /the   steak that   his/the   appetite disappeared
     'Klara was looking at everybody's steak in such a strict manner that their appetite disappeared.'

(10) a. *They passed through every small village. #The church was locked.*
      b. *They arrived in a small village. The church was locked.*

We assume that the Landmark theta head comes with a binder feature [+b] which leads to structure expansion along the lines of Hole's (2014) Generalized Binder Rule in the tradition of Büring's (2005) Binder Rule; cf. (11).

(11) Generalized Binder Rule (Hole 2008, 2012, 2014)

$$\theta_{LDM}P \quad\Rightarrow\quad \theta_{LDM}P$$
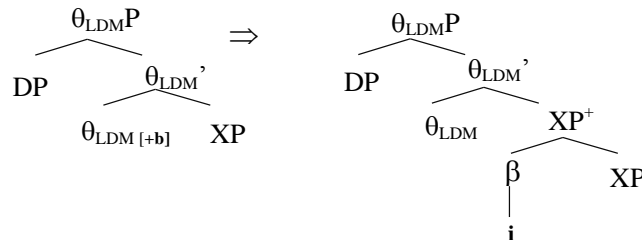
The output of (11), with the bare index c-commanding the XP, makes sure that, after Predicate Abstraction, a variable in the XP gets a value determined by the Landmark DP. (This rule, just like Büring's Binder Rule, does not conform to inclusiveness. It could easily be reformulated so as to conform to inclusiveness, however: cf. section 2.3 below for compositional details). Even though in this implementation binding is triggered by theta heads, we will continue to use the common parlance of DPs that bind variables.

2.2.   Knight Move Binding

Hole (2008, 2012, 2014) shows that free datives trigger binding in a particular tree-geometric configuration. He calls this particular binding configuration "Knight Move Binding" (*Rösselsprungbindung* in German). Similar to knights in the chess game, who may only move in a specific oblique way (two squares in any non-diagonal direction, then one to the left or right), a free dative may only bind the possessor on the left branch of a prepositional co-argument. Knight Move Binding can be defined as in (12).

(12)   Knight Move Binding
        Binding configuration in which the binder targets the left branch of a c-commanded co-phasal DP.
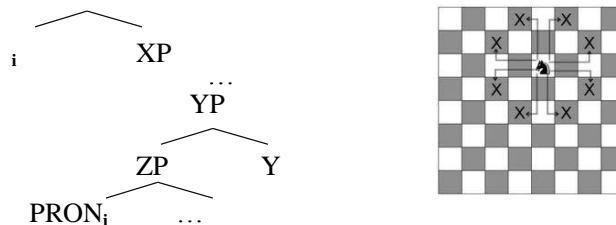
If DPs and VoicePs are phases, and if derivation by phases is assumed, Knight Move Binding is a consequence of spell-out by phases. The following three observations support the idea that Knight Move Binding is the single massively-privileged binding configuration in natural language: (i) grammaticalization of reflexive pronouns are from body part DPs 'x's body part', never from representation nouns like 'picture/statue/… representing x'; (ii) bound pronouns in argument positions move to the left edge of their DPs (Reuland 2011:275); (iii) free datives and other extra arguments typically bind in a Knight Move Binding configuration (Hole 2006).

2.3. A sample derivation

This section provides an analysis of example (13a) (=(7)) along the lines of Hole (2014). In this example, the free dative argument *jedem Jungen* 'every boy$_{DAT}$' is introduced by a Landmark theta head, with the binder feature as discussed above, and it leads to the result that the DP in its specifier binds the possessor in the possessive DP *seiner Hose* 'his trousers'. As Bound Bridging Definites – just like possessive DPs – contain a possessor variable, they can receive the same analysis. (13b) provides the composition of the meaning of the relevant clause part, indicated by square brackets.

In this analysis, the Landmark theta head, with its binder feature, leads to the structure expansion triggered by the Generalized Binder Rule in (11). On the semantic side, this results in Predicate Abstraction over the possessor argument. The Landmark theta head combines with its complement by way of (Davidsonian) Predicate Modification.

(13) a. *dass* [*jedem Jungen* θ$_i$ *ein Taschentuch aus   seiner$_i$ /der$_i$ Hose   hängt*]
          that   every boy$_{DAT}$ a   handkerchief out-of his   the   trousers hangs
          'that a handkerchief hangs out of every boy's trousers'
      b. For any assignment g and number i:[5]

$⟦$ *jedem Jungen* θ$_{LDM}$ i *ein Taschentuch aus der$_i$ Hose häng-* $⟧^{g[i \to y]}$ =
λs. ∀x [boy(x)(s) = 1 → s is a state of a handkerchief hanging out of x's trousers &   [FA]
x is the landmark of s = 1]

                                                                                      [DPM]

$⟦$ *jedem Jungen* $⟧$ = $⟦$ θ$_{LDM}$ i *ein Taschentuch aus der$_i$ Hose häng-* $⟧^{g[i \to y]}$ = λy. λs.
λP. λs. ∀x [boy(x)(s) =   s is a state of a handkerchief hanging out of y's trousers &
1 → P(x)(s) = 1]   y is the landmark of s

                                                                                      [PA]

$⟦$ θ$_{LDM}$ $⟧$ = λy. λs. y $⟦$ i *ein Taschentuch aus der$_i$ Hose häng-* $⟧^{g[i \to y]}$ = λy. λs.
is the landmark of s   s is a state of a handkerchief hanging out of y's trousers

                                                                                      [FA]

                    i $⟦$ *ein Taschentuch aus der$_i$ Hose häng-* $⟧^g$ = λs. s is a
                               state of a handkerchief hanging out of g(i)'s trousers

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[5] We use the following abbreviations: DPM: Davidsonian Predicate Modification, FA: Functional Application, PA: Predicate Abstraction, DPM: Davidsonian Predicate Modification.

After the insertion of the dative DP, the result of the composition can be paraphrased as "Every boy *x* is such that *x* is the landmark of the state *s* of a handkerchief hanging out of *x*'s trousers, and *s* holds in the neighborhood of *x*'s trousers".

In the analysis (13b), we did not decompose the PP *aus der Hose* 'out of trousers'. However, for our analysis of *be*-prefixed verbs in the next section, we will decompose PPs into smaller pieces, in order to render transparent the similarity between spatial prepositions like *aus* and verbal prefixes like *be-* .

To conclude this section, Hole (2012, 2014) provides an analysis of free datives in terms of a binding voice akin to reflexivization: free datives always bind a variable in the local tense domain in the "Knight Move Binding" configuration. The binding requirement comes into the structure together with the theta head licensing the dative DP. Hole's binding account of free datives is developed in the agent-severed neo-Davidsonian Voice framework of Kratzer (1996). The bound variable in the free dative Voice is always situated at the left edge of a co-argumental possessum (or purpose) phrase. This binding configuration is called "Knight Move Binding".

3. Analysis of the locative alternation with *be*-verbs

In this section, we will apply the main ingredients of the analysis of free datives to the locative alternation with *be*-verbs in German.

3.1. General properties of the locative alternation with *be*-verbs

The locative alternation with *be*-verbs in German corresponds to the so-called *spray/load*-type locative alternation in English as described in Levin (1993:50). It involves a locatum argument − the substance or entity whose location is changed − and a location argument (Dowty 1991, Levin 1993:50, Van Valin and Lapolla 1997). This form of alternation is found with transitive verbs of directed motion relating to putting and covering.

In the base alternant of the *spray/load*-type locative alternation in German, the locative argument is realized in a PP. In the non-base alternant, in the so-called *be*-applicative, the location argument receives coding as a direct object and the verb is usually prefixed with *be-*, cf. (14/15). According to Wunderlich (1987), *be-* expresses some (external or internal) contact of the moved object with the location object (or, more generally, that the former is located in the topological proximity of the latter).

(14) *Be*-applicative: *den Kuchen*$_{Location}$ (*mit Eigelb*$_{Locatum}$) ***be-streichen***
                          the cake$_{ACC}$ with egg.yolk   *be*-spread
(15) Base*: Eigelb*$_{Locatum}$ *auf den Kuchen*$_{Location}$ *streichen*
              egg.yolk$_{ACC}$ on the cake   spread

The locative alternation of the *spray/load* type in English and German has been given many descriptions and analyses in the literature. Eroms (1980) and Günther (1987) describe the

locative alternation in German as a "local phrase passive". In his semantic analysis of *be*-verbs participating in the locative alternation in German, Wunderlich (1987) considers *be-* as a preposition incorporated into the verb in the lexicon. This incorporation leads to the identification of its arguments with the arguments of the verb.

Another type of analysis, to which our analysis will be more similar, assumes no transformation or derivation of one construction from the other. Michaelis & Ruppenhofer (2000, 2001), in their analysis of *be*-verbs in the framework of Construction Grammar, suggest that *be*-verbs, which are derived not only from verbs but also nouns and adjectives, acquire a verbal argument structure pattern via combination with a particular construction. The analysis of the locative alternation of *spray/load* type in English by Rappaport & Levin (1988) goes in a similar direction. The authors assume that the alternation is the result of the verb or verbal root being associated with two different lexical semantic structures. As shown in (17), the lexical semantic structure of the locative variant (16) is part of the *with* variant.

(16) locative variant of *load:* [x CAUSE [y TO COME TO BE AT z] / LOAD]
(17) *with* variant of *load:* [x CAUSE [z TO COME TO BE IN STATE]]
      BY MEANS OF [x CAUSE [y TO COME TO BE AT z] / LOAD]

The subsumption of the lexical semantic representation of the locative variant under that of the *with* variant is motivated by the intuition that the *with* variant entails the locative variant, but not vice versa. What is remarkable in the representation (17) is the double occurrence of the location argument z in the *with* variant. However, the authors do not discuss this co-occurrence from the point of view of co-argumental binding. For lack of space, we will not go into the so-called "holistic effect" frequently discussed in the context of locative alternation.

Many ingredients of the previous analyses, such as incorporation of the preposition *be-* into the verb, the composition of the meaning of locative construction and the view of the locative alternation as a "local phrase passive", are helpful, and we will integrate them in an adjusted form into our analysis. However, what should have become clear from our short overview of the analyses of locative alternations is that the phenomenon of co-argumental binding in *be*-locative constructions has not received any attention in the literature. We think, however, that co-argumental binding in *be*-constructions is a crucial ingredient of their syntax and semantics. Thus, the locative construction with the *be*-verb has hidden material in it which relates to one of the accusative referent's neighborhood regions, viz. SURFACE. The accusative location argument obligatorily binds the possessor of this neighborhood region. The bound variable can be made explicit as in (18).

(18) *den Kuchen$_i$ {an seiner$_i$ Oberfläche} mit Eigelb   **be**-streichen*
       the cake$_{ACC}$ on its   surface   with egg.yolk *be*-smear
       'coat the cake with egg yolk on its surface'

In cases in which neighborhood regions other than SURFACE (typically INSIDE) co-occur with *be*-prefixed verbs, we are dealing with non-productive uses of *be-*; cf. the unpredictable behavior of cases relating to INSIDE in (19a) vs. (19b). (19c) is a case of productive *be*-prefixation, and it renders explicit the restriction to a particular substructure of the object, namely its SURFACE (Brinkmann 1997). In the base alternant of (19c) (*in/auf das Buch malen* 'paint something inside/on the book'), the object's inside or its surface could, in principle, be involved in the activity described by the verb. In the non-base alternant of the productive example (19c), however, the reading that the inside of the object is affected is excluded.

(19)   a. *das Loch {innen} mit Wachs **be**-stopfen*[6]
          the hole_ACC inside with wax   *be*-stuff
          int.: 'stuff the hole with wax'
          base: *Wachs in das Loch stopfen*

       b. *den Tank {innen} mit Benzin   **be**-füllen*   [not productive]
          the tank_ACC inside with gasoline *be*-fill
          'fill the tank with gas'
          base: *Benzin in den Tank füllen*

       c. *das Buch   {von außen /*von innen} **be**-malen*   [productive]
          the book_ACC from outside/from inside   *be*-paint
          'paint the book {on the outside/*on the inside}'
          base: *etw. in/auf das Buch malen*

The topological restriction of the prefix *be-* to a particular substructure of the location – its SURFACE – must be part of the meaning of the *be*-locative construction. This restriction can be tied to a fact from language history. Etymologically, the prefix *be-* is related to the preposition *bi*, which denoted spatial relationships equivalent to those denoted by *bei* 'near/at', *um* 'around' and *an* 'at' (Paul 1920, Stiebels 1991); all of these involve the surface of objects.

3.2. Decomposing prepositional phrases

In our analysis of free datives in Section 2, PPs were analyzed in a traditional fashion. Because we analyze *be*-prefixed verbs in this paper, and the prefix *be-* originates from a local preposition, we will elaborate on the internal structure of prepositional phrases.

A preposition typically relates two arguments in a spatial configuration: the Figure and the Ground. The Figure argument (locatum) is the entity located with respect to the Ground argument (the reference object, relatum). An object serves as a Ground if it is combined with a preposition (cf. 20)/(21).

(20)   The kids put decorations_i [e$^{FIGURE}_i$ on the tree^{GROUND}].

---

[6] According to Brinkmann (1997:185), other verbs of this type: *klemmen* 'pinch/squeese', *quetschen* 'jam' and *zwängen* 'wedge/jam'. Some of them allow for *be*-prefixation, although without locative meaning, cf. *beklemmen* 'constrict/oppress'.

(21) [FIGURE [on GROUND]]

In order to account for the Figure/Ground distinction, and to combine this distinction with the idea of the syntactic severance of non-internal arguments (Kratzer 1996, among others), it was suggested in the syntactic literature that a prepositional phrase has a split phrase structure.

3.2.2. The split-P hypothesis (Zhang 2002, Svenonius 2003)

Svenonius (2003), among others, proposes a syntactic analysis of PPs, as in (22a), parallel to VPs, as in (22b). V and P decompose in similar ways and the external argument of either is introduced by a separate functional head. Little p introduces the Figure as an external argument of the preposition, parallel to Kratzer's (1996) Voice introducing the external argument of the verb, and P introduces the Ground as complement. The phrase *the book on the table* with the local preposition *on* can then be represented as in (23).

(22) a.

pP
- DP Figure
- p'
  - p
  - PP
    - P
    - DP Ground

(Svenonius 2003)

b.

vP
- DP Agent
- v'
  - v
  - VP
    - V
    - DP Patient

(23) *the book on the table*

pP
- DP *the book*
- p'
  - p
  - PP
    - P *on*
    - DP *the table*
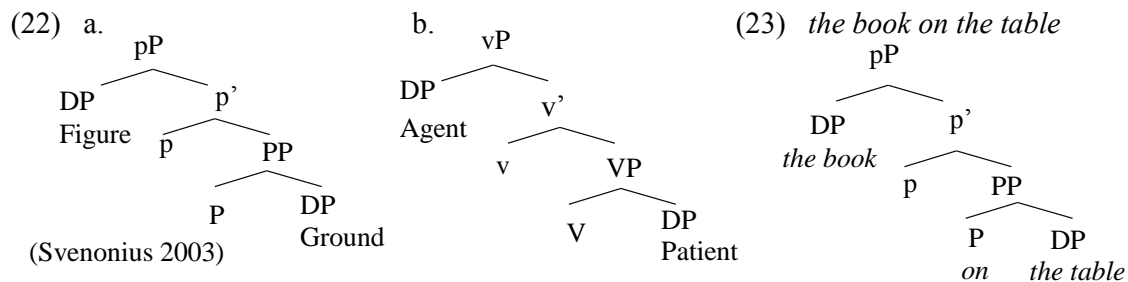
According to Svenonius, local prepositions such as *on* are inserted in P. Note that, semantically, P selects a particular spatial part of the Ground DP referent, specifically a neighborhood region. For example, *on* requires the Ground to be construed as an outside, while *in* would take a Ground construed as a container with an inside. Although neighborhood regions, such as inside or outside, are an integral part of the meaning and of the prepositional phrase structure, they are not represented in the Split-P structure of Svenonius (2003). In Chinese, such neighborhood regions are overtly specified if a preposition is used, and an optional overt relational P element *-mian* meaning 'side/face' may be used.

(24) Chinese (Zhang 2002:49)

a. zai xiangzi shang(-mian)
   at chest sur-face
   'on the chest'

b. cong xiangzi xia(-mian)
   from chest   under
   'from under the chest'

c. wang xiangzi li(-mian)
   to   chest in-side
   'in(to) the chest'

Spatial expressions like *shang(-mian)* 'sur-face' refer to what Zhang (2002) calls *place value*. She suggests that place values are merged as P, cf. the following syntactic representation for the pP in (24a):

(25) Zhang (2002) (our labels; L.G. & D.H.)

```
                 pP
              /      \
            p          PP
          zai        /    \
          'at'    DPᵢ       P'
               xiangzi    /    \
               'chest'   P      DP
                      shang-    tᵢ
                      mian
                     'sur-face'
```
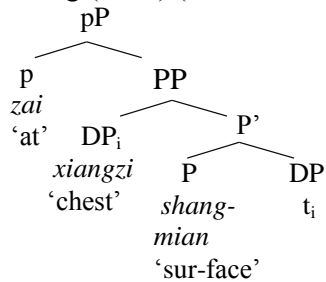
The reference object *xiangzi* 'chest' is merged as a complement of P and moves to the specifier of P.

3.2.3. The new split-P hypothesis

While we agree with Svenonius (2003) on the general idea of split phrase structure for prepositional phrases, we propose to represent neighborhood regions as explicit components of the structure, as suggested by Zhang (2002). We assume that P is realized by a relational expression, such as *side/face* corresponding to Chinese *-mian*, and that this relational expression is specified by the complement of P. The complete PP refers to a particular neighborhood region of the reference object in its specifier. The preposition *auf* in German or *on* in English can be decomposed into [AT + SURFACE], where AT expresses general spatial relatedness. One level up, AT inserted in p introduces the Figure and relates it to the Ground, specified in the complement PP of p as the SURFACE of the reference object.

(26) a. *the book on the table = "the book AT the table's SURFACE"*
      b.
```
              pP
           /      \
       the book     p'
       Figure    /     \
                p        PP
                AT       Ground
                       /      \
                the table's    P'
                             /    \
                            P      SUR-
                            -FACE
```
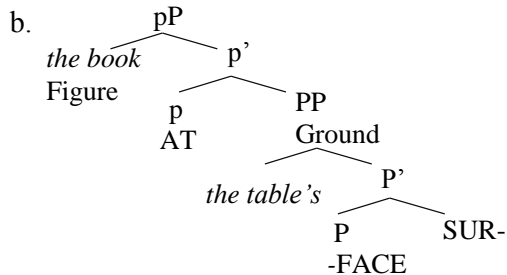
3.3. Analysis

As a starting point, we would like to recapitulate two properties of free datives. Property (i): free datives are introduced in the syntax. This means that free datives are extra arguments, i.e., they are not available in the base alternant, and are added in the syntax of the non-base alternant, cf. (27). Thus, if the dative argument is not realized, the entailed involvement of every boy in the event disappears, too. Property (ii): Free datives obligatorily bind a possessor variable in the local tense domain.

(27) *Jedem Jungen*ᵢ *hängt ein Taschentuch aus   der*ᵢ *Hose*
      every boy_DAT hangs a   handkerchief out-of the   trousers
      'A handkerchief hangs out of every boy's trousers'
      base: *ein Taschentuch hängt aus der Hose*

To account for (i), in Section 2 it was assumed that free datives are introduced by a verbal theta head, a type of voice head called Landmark. Property (ii) was derived by assuming that the Landmark theta head has a binder feature that leads to some possessor variable in the configuration of Knight Move Binding getting bound by the DP in the specifier of the Landmark head. We would like to propose that many syntactic constructions can successfully be described by applying the mechanism of theta-induced binding by (Landmark, and other) theta heads. The locative alternation with *be*-verbs in German is one such example. As we have already shown, in *be*-constructions the location argument, i.e., the argument spatially related to the eventuality, obligatorily binds a possessor argument in the local tense domain, as shown in (28). Thus, *be*-constructions share the binding property (ii) with free datives.

(28) (=3') *den Kuchen*ᵢ {*an seiner*ᵢ *Oberfläche*} *mit Eigelb   **be***-*streichen*
           the cake_ACC   on   its   surface   with egg.yolk *be*-smear
           'coat the cake with egg yolk on its surface'

Moreover, *be*-constructions share with free datives property (i), concerning the status of the binder DP. We assume that the location argument of *be*-verbs is introduced in the syntax. However, there is a difference between free datives and location arguments of *be*-verbs. In the free dative construction, the location argument is not available in the base alternant and furthermore is not entailed if omitted. In the locative construction (29), the location argument is lexically required by the verb both in the non-base and in the base alternant. It cannot be omitted (Kratzer 2006: 178). But if it is omitted in the base alternant in (29), the entailment that there is some place where egg yolk was smeared remains stable. Put differently, dropping the locative argument in the base alternant preserves the thematic entailment of the omitted PP. Hence, the location argument is lexically required by the verb.

(29) *den Kuchen mit   Eigelb   **be***-*streichen*
      the cake_ACC with egg.yolk *be*-smear
      'coat the cake with egg yolk'
      base: *Eigelb auf den Kuchen streichen*

However, the realization of the location argument as a direct object with accusative case in the non-base alternant indicates its syntactic promotion from the base alternant. Note that we use the term *promotion* descriptively, without assuming a movement or a lexical derivation approach. Despite this promotion parallel, recall that we subscribe to a neo-constructionist

approach in our domain. Hence, what may be described as promotion to object in (29) is, in our analysis, just an indirect correspondence.

Analogous to analyses of passives which assume a passive voice head introducing external arguments (e.g., Alexiadou & Doron 2012), we assume that a special voice or theta head is responsible for the syntactic realization of the location argument in *be*-constructions, and hence for its "promotion". This is the Landmark theta head. Thus, the effect of promotion of the location argument in *be*-constructions comes from the realization as a specifier of that particular voice head.

In what follows, we provide a syntactic analysis of our example of the locative alternation with the base alternant in (30) and with the *be*-alternant in (30b).

(30) a. *das Eigelb   auf den Kuchen streichen*   b. *den Kuchen mit Eigelb **be**-streichen*
       the egg.yolk on the cake$_{ACC}$ smear   the cake$_{ACC}$ with egg.yolk *be*-smear

```
(30a)
        ...
         |
        VP
       /  \
     DP    V'
das Eigelb_j  / \
            pP   V
           /     streich-
         p'
        /  \
      DP    p
     PRO_j / \
          p   PP
          AT / \
           DP   P'
      den Kuchen / \
               P   OBER-
                  -FLÄCHE

(30b)
          ...
           |
        θ_LDM P
        /     \
      DP      θ_LDM'
  den Kuchen  /   \
          θ_LDM   CauseP+
             i    /    \
                     CauseP
                    /     \
                Cause     VP
                        /    \
                      pP      V
                     /  \     streich-
              mit Eigelb p'
                        / \
                       p   PP
                       AT / \  ∃  V
                       pro_i  P'
                             /  \
                            P   OBER-
                               -FLÄCHE
```
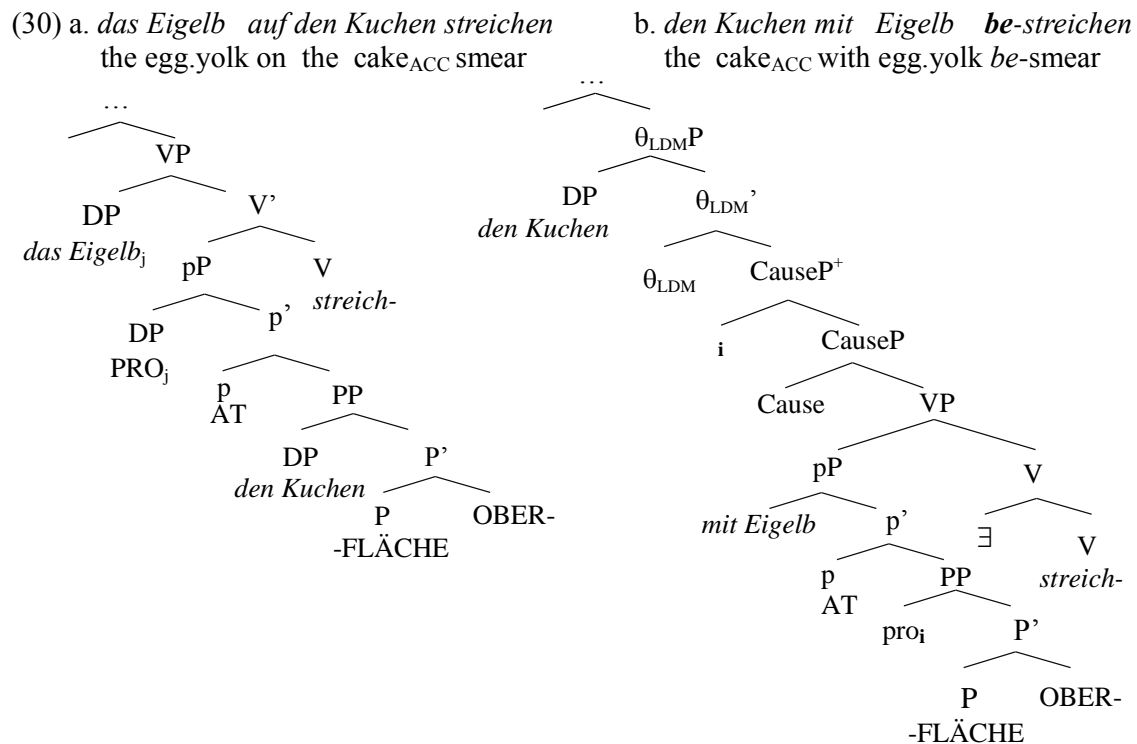
In the structure of the base alternant (30a), the preposition *auf,* decomposed as [AT OBERFLÄCHE], projects the PP relating *den Kuchen* and its surface. It is the complement of p, in whose specifier the PRO relating to the locatum *das Eigelb* is accommodated. The whole pP (or rather AspP structure; not added here to preserve perspicuity, but cf. den Dikken 2008) is taken as the directional complement of *streich-* 'smear' as its first argument. Its second argument is *das Eigelb* (the PP provides the Ground for the Figure *das Eigelb* in Spec,p). Now we turn to (30b); cf. (31) for compositional details.

(31) a. *den Kuchen   mit   Eigelb   **be**-streichen*[7]
      the cake$_{ACC}$ with egg.yolk *be*-smear
   b. For any assignment g and number i:

θ_{LDM}P

$[\![$ *den Kuchen* θ_{LDM} i CAUSE (*mit*) *Eigelb be-* pro$_i$'s OBERFLÄCHE *streich-* $]\!]^{g[i\to x]}$ =   [FA]
λe. $\exists$s [s is a state of egg-yolk being AT the surface of the cake & s is a state of something
having been smeared somewhere & CAUSE(s)(e) & the cake is the landmark of e]

DP θ_{LDM}'
$[\![$ *den Kuchen* $]\!]$ = $[\![$ θ_{LDM} i CAUSE (*mit*) *Eigelb be-* pro$_i$'s OBERFLÄCHE *streich-* $]\!]^{g[i\to x]}$ =   [DPM]
den Kuchen λx. λe. $\exists$s [s is a state of egg-yolk being AT the surface of x & s is a state of
                           something having been smeared somewhere & CAUSE(s)(e) & x is the
                           landmark of e]

      θ_{LDM}'   CauseP$^+$
$[\![$ θ_{LDM} $]\!]$ = λx λe. $[\![$ i CAUSE (*mit*) *Eigelb be-* pro$_i$'s OBERFLÄCHE *streich-* $]\!]^{g[i\to x]}$ =   [PA]
x is the landmark of e λx. λe. $\exists$s [s is a state of egg-yolk being AT the surface of x & s is a
                             state of something having been smeared somewhere & CAUSE(s)(e)]

                    i   CauseP
                       $[\![$ CAUSE (*mit*) *Eigelb be-* pro$_i$'s OBERFLÄCHE *streich-* $]\!]^g$ = λe.   [FA]
                       $\exists$s [s is a state of egg-yolk being AT the surface of g(i) & s is a state
                       of something having been smeared somewhere & CAUSE(s)(e)]

              Cause   VP   [FA]
         $[\![$ *cause* $]\!]$ = $[\![$ (*mit*) *Eigelb be-* pro$_i$'s OBERFLÄCHE *streich-* $]\!]^g$ =
λP$_{\langle s,t\rangle}$. λe. $\exists$s [P(s) & CAUSE(s)(e)] λs. s is a state of egg-yolk being AT the surface of g(i) &
                                      s is a state of something having been smeared somewhere

                                        pP   V
[PM] $[\![$ (*mit*) *Eigelb be-* pro$_i$'s OBERFLÄCHE $]\!]^g$ $[\![$ $\exists$ *streich -* $]\!]$ = λs. s is a state of
            = λs. s is a state of egg-yolk being AT the   something having been
            surface of g(i)   smeared somewhere

[FA] $[\![$ (*mit*) *Eigelb* $]\!]$ =   p' $\exists$ V
         Eigelb $[\![$ *be-* pro$_i$'s OBERFLÄCHE$]\!]^g$ = $[\![$ *streich-* $]\!]$ =
                                      λx. λs. s is a state of x being AT λx. λy. λs.
                                      the surface of g(i)   s is a state of y
                                                                                 having been
                                   p   PP   smeared on x
[FA] $[\![$ *be-* $]\!]$ = $[\![$ pro$_i$'s *Oberfläche* $]\!]^g$
                         λy. λx. λs. s is a state   = g(i)'s surface
                         of x being AT y
                                              DP   P'
[FA] $[\![$ pro$_i$ $]\!]^g$ = g(i) $[\![$ OBERFLÄCHE $]\!]$ = λz. z's surface

                                                          -FLÄCHE   OBER-

---

[7] A quantifier as *jeden Kuchen* 'every cake' would yield the clear binding interpretation. For lack of space we
use a definite DP *den Kuchen* 'the cake' here.

Surface contact verbs, such as *streichen* 'smear', belong to the class of directed motion verbs with two internal arguments (Levin 2006). They describe activities. The *be*-prefixed alternant *be-streichen* goes along with a causative event structure and entails two subevents: a causing event and the resultant state. Such a causative predicate can be represented following Kratzer (2005:200) and adjusted to our conventions, as in (32), where *s* is a state and *e* an event argument. The Cause predicate is merged as a head of CauseP. The Cause head takes a VP denoting a result state as its complement.

(32) $\lambda P. \lambda e. \exists s [P(s) \& CAUSE(s)(e)]$

Parallel to our analysis of free datives, the location argument *den Kuchen* in (30b) is introduced by the Landmark theta head θ_{LDM}. This head enters the derivation above the CauseP. This means, then, that the cake is the landmark of the complex c-causes-s event, and not just of the result state.

The prefix *be-* with the meaning AT is merged in p. It relates the Figure *Eigelb* in its specifier to the Ground denoted by the PP. *Be-* selectively restricts its PP-complement. It must refer to the surface of some reference object. P takes a location argument and relates it to its surface (OBERFLÄCHE 'surface' is decomposed into OBER- 'sur-' and -FLÄCHE '-face', where FLÄCHE has a weak locative relational semantics).

V introduces the result state. We assume that both object arguments of the state description in V are existentially bound, and only the stative event argument is left compositionally active. When this "semantically truncated" verb combines with the locative pP, it merely contributes manner information as to the type of state in which the figure and ground argument related in the pP are involved. The arguments existentially bound in the V are indirectly identified with the arguments introduced in the pP, by way of Predicate Modification.

The Landmark function maps the referent of the DP in its specifier to its neighborhood regions and entails that the causing event and the resultant state hold within those neighborhood regions. The Landmark theta head as proposed by Hole (2012, 2014) comes with a binder feature [+b]. The binder feature requires some variable in its c-command domain to be bound by the DP in its specifier. This binding requirement leads to structure expansion of CauseP to CauseP$^+$, along the lines of the Generalized Binder Rule in (11). To arrive at the denotation of θ_{LDM}', Davidsonian Predicate Modification in employed. The landmark DP is added. After existential closure of the event variable at the end of the derivation, (31) has the truth-conditions in (33).

(33) $\exists e \exists s$ [s is a state of egg-yolk being AT the surface of the cake & s is a state of
         something having been smeared somewhere & CAUSE(s)(e) & the cake is the
         landmark of e]
         'There is an event that causes the result state in which the cake is smeared with egg
         yolk on its surface.'

Some remarks are in order concerning the binding configuration in (31). We subscribe to the syntactic assumption of derivation by phases. This means that the binding relations discussed here must all hold within a single phase; however, the pP in (31) ought to be a phase itself. Hence, it is not immediately clear how the landmark DP may bind into the complement of p. However, den Dikken (2007) presents strong evidence that the movement of elements like *be-*, a movement that we have to assume anyway to derive the surface syntax of *be*-prefixation, leads to phase extension up to the level of VP.[8] Making use of the general idea of phase extension, we will assume an analysis that has *be-* incorporating into the verb in the overt syntax. What is more, V movement of the *be*-prefixed verb, at least up to Voice, via θ_{LDM}, will further extend the phase in such a way that the landmark DP and the bound variable end up being co-phasal at the point of spell-out. Note that the structure which gets interpreted in (33) is a representation either after reconstruction or without PF-movement, if *be*-incorporation and V movement are PF-movement. In this way, the Landmark phrase inherits phasehood via p-to-V-to-CAUSE-to-θ_{LDM} movement. As pro is on the left branch of the PP, the binding configuration within a single (extended) phase corresponds to the configuration we defined as Knight Move Binding in Section 2.

4.   Conclusion and broader impact

In this paper we have shown that, just as with free datives, theta induced Knight Move Binding can be used to model the locative alternation involving *be*-prefixation in German. We think that the ingredients of our proposal can be put to use in a wide variety of alternations which we call "Location Promotion" alternations. In such alternations, the location argument serves as a subject, direct object or a dative object in the non-base alternant, whereas the base alternant typically has the location argument embedded in a pP/PP. Two examples are provided in (34) and (35).

(34) *Er nahm den   Fisch$_i$ aus* [out of pro$_j$'s INSIDE].   (Particle verbs)
     he took   the$_{ACC}$ fish   out
     'He took the guts out of the fish.'

(35) *Der Gang   steht voll mit Kartons*.   (Stative locative alternation (Hole in prep.))
     the corridor stands full with cardboard-boxes
     'The corridor is [standing] full of cardboard boxes.'

Our analysis of theta induced binding laid out in this paper raises the following questions: (i) Why do theta heads and variable binding/reflexivization appear to be such a good match? (ii) Can the theta-heads-as-binders idea be generalized further? (iii) Why is Knight Move Binding such a privileged tree-geometrical instantiation of variable binding? We hope that further research in this area will shed light on these questions.

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[8] For other proposals treating *be-,* and other verbal prefixes in German, as incorporated prepositions, cf. Biskup & Putnam (2009) or Wunderlich (1987).

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Emotive predicates and the subjunctive: a flexible mood OT account based on (non)veridicality[1]

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Abstract. We address *flexible* embedded mood patterns, i.e. cases where (a) the same type of verb selects indicative in one language but prefers subjunctive in another, or (b) both moods may be allowed in a single language. We focus on emotive predicates as an illustration of our approach. Emotive predicates allow subjunctive and indicative (with preference for the former) in Italian. Such flexible patterns have not been discussed much in the literature because they are problematic for existing theories which predict the facts of one language but not the other. We propose that the correct account of embedded mood choice is sensitive to both what the embedding predicate *asserts* and what it *presupposes*. We argue that mood morphemes have definedness conditions that make them sensitive to aspects of the (non)veridicality of the embedding predicate, and implement an optimality theoretic account that captures opposing tendencies in Greek and Italian.

Keywords: emotive-factives, subjunctive, non-veridicality, optimality, Greek, Italian.

1. Emotive predicates and the subjunctive mood

This paper explores flexible mood patterns, focusing particularly on emotive-factive predicates. Across languages these predicates select both the indicative and the subjunctive. Choice of the subjunctive is observed in French and Italian.

(1) a. Jean *regrette* que Marie ait   lu   ce livre.
         John regrets that Mary have.3SG.SUBJ read this book.

  b. Gianni *rimpiange* che Maria abbia   letto questo libro.
      John   regrets   that Mary have.3SG.SUBJ read this   book.

      John regrets that Mary has read this book.

Greek chooses the indicative:

(2) O Pavlos *lipate*   pu efije   i   Roxani.
     the Paul   regrets..3SG that. left.3SG the Roxani.
     'Paul knows/believes that Roxanne left.'

The subjunctive is unexpected because emotive verbs are thought to be *factive*, *presuppositional* (Kiparsky and Kiparsky 1968, Karttunen 1973), and *veridical* (Giannakidou 1998, 2006, 2015). Their non-emotive cousins meaning *know* take the indicative:

(3) a. Jean *sait*   que Marie a   lu   ce livre.
         John knows that Mary have.3SG.SUBJ read this book.
     b. Gianni *sa*   che Maria ha   letto questo libro.
         John   knows that Mary have.3SG.SUBJ read this   book.
         John knows that Mary has read this book.

The factive verb *know* selects the indicative, the mood of veridical sentences (Giannakidou *ibid.*). If emotives are factive like *know*, why do they take the subjunctive? If both *know* and emotives are veridical, how can we explain the contrast between the two vis-à-vis the subjunctive?

The usual way mood selection in complement clauses has been handled in the literature is by proposing a generalization about the decisive property that necessitates subjunctive or indicative. Simple generalizations have been proposed: for instance, that emotive verbs are veridical (Marques 2004, Baunaz 2015), that they denote preference between two alternative propositions (Villalta 2008). Related notions have been used, e.g. epistemic commitment (Smirnova 2012), and contextual commitment (Portner and Rubinstein 2013), to mention just some of the most recent approaches. Unfortunately, none of the approaches offers a satisfactory way to address the emotives because the treatment is monolithic, i.e. the selecting predicate is veridical or nonveridical, or has or does not have the required property for the subjunctive. The problem becomes more acute when we consider that the emotive class varies with respect to whether it takes the subjective or the indicative. Giannakidou (2015) offers data and references indicating three types of languages:

- Languages that require subjunctive (Spanish, Italian,[2] French, as above);

- Languages that allow both subjunctive and indicative ((Brazilian) Portuguese, Catalan, Turkish);

- Languages where emotives select indicative (Greek, Hungarian, Romanian, Bulgarian).

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[2]We will discuss later in the paper a few exceptions to this generalization.

Veridicality and epistemic commitment predict indicative after emotives (therefore capture the languages in 3), while preference accounts address the subjunctive in languages in group 1. The accounts are therefore at best partial, and no approach can be generalized to predict the observed variation, and the potential of dual patterns.

The variation illustrates, in the clearest way, the complexity one is confronted with when trying to establish a general pattern of mood choice across a number of languages, and how difficult it is to come up with a single generalization that will be able to handle all cases. In the present paper, we take the variation to suggest that a more nuanced approach is needed, one that might allow verb meanings to combine veridical with nonveridical components. This can be done if we distinguish between what a selecting verb *asserts* and what it *presupposes*. Once we make this distinction, we see that verb meanings can exhibit what we call *mixed* (non)veridicality, i.e. they can combine a nonveridical assertion with veridical presupposition and vice versa. Emotives, we argue are precisely one such case; Giannakidou and Mari (2015b), in a larger detailed study of many selecting verbs, show that the number of predicates with mixed (non)veridicality is quite large. Upon closer scrutiny, it becomes clear that indeed many lexical entries are mixed, therefore flexible with respect to mood choice, as it indeed appears to be the case also in classes beyond the emotive one.

In the present paper, we use the emotive class as a window to rethink the fundamental issues arising with mood selection in complement clauses. We offer a two-tier theory that can to explain the three patterns observed, extending the view that mood selection, as a grammatical phenomenon, is sensitive to the property of (non)veridicality. We offer two refinements: (a) we distinguish between (non)veridicality in the assertion vs. presupposition, and (b) we allow the subjunctive/indicative morphemes to be sensitive to (non)veridicality in either level.

Before we start with the analysis, let us offer one more piece of background. Emotive predicates are also well known for allowing negative polarity items (NPIs) to appear in their complements; see Backer (1970), Linebarger (1987); for more recent discussion Giorgi and Pianesi (1996), Giannakidou (2006):

(4) a. Ariadne regrets that she *ever* read that book.
     b. Ariadne is glad that we got *any tickets* at all.

The NPI licensing is typically attributed to some kind of negativity. Backer (1970) says that emotives express a relation of *contrariness* between a fact and some mental or emotional state. He claims that "We say that we are surprised when a certain fact does not conform to our expectations; relieved when it does not conform to our fears; disappointed when it is not in line with our hopes. Likewise, we say that a certain fact is odd or strange if it seems counter to our view of what is logical." Giannakidou (2006), following Linebarger (1987), argues that the NPIs *ever* and *any tickets* are sanctioned in the emotive clause via this contrariness, and suggests that the inference

is "not merely a conversational implicature, but rather something stronger" (Giannakidou *ibid.*: 595). In this paper, we show that the contrariness of the emotives is *not* a defining element of all emotives, but what renders them nonveridical is their *gradable* nature. At the same time, they have a veridical presupposition, and this explains the observed variation in mood selection. Emotives, then, have what we call *mixed* veridicality and this category comes with flexible mood patterns. Predicates meaning *hope, be aware* are also mixed, as we show. In our analysis here, we cast the role of subjunctive and indicative, and their sensitivity to (non)veridicality (Giannakidou 2009) who argues that the subjunctive is a polarity item) via definedness conditions. These definedness conditions are presuppositions of the mood particles. In contrast to the subjunctive which is akin to an NPI, the indicative is understood as a positive polarity item (PPI), requiring veridicality— in the assertion or the presupposition, and this explains why Greek possesses two indicative particles, as we see next.

Within this school of thought considering subjunctive sensitive to nonveridicality (Giannakidou 2009),[3] the idea that presuppositional content of the predicate can drive the choice of mood is for the first time clearly formulated in Mari (2014). Mari studies implicative modals as well as the implicative verb 'manage to'. The latter selects the subjunctive in Greek and, given the veridicality in the assertion, this choice pattern is also unexpected under current theories. Mari (2014) demonstrates that 'manage to' has a modal, non-veridical presupposition and argues that the presuppositional content is able to determine mood in the embedded clause. In so doing, Mari paves the way to rethink mood choice as driven by non-veridicality at either one of the levels of meaning, the assertion or the presupposition.[4]

We start in section 2 by presenting the core selection patterns. In section 3, we present the framework of nonveridicality for mood choice, with particular emphasis on the objective and subjective dimension of (non)veridicality. In sections 4 and 5 we present our analysis of emotives. We argue that they combine a veridical presupposition with a nonveridical assertion. The latter emerges via an emotive scale. The scale is then mapped onto the space of possible worlds and divides it into worlds where the emotions hold (positive extent), and those where it doesn't (negative extent). The existence of a scale thus creates a nonveridical space, in effect unifying the scalar with the truth based aspects of mood choice.

2. Main selection patterns in Greek, Italian, and French

Mood choice has been a central issue in semantics, both formal and descriptive, but we will not attempt a general overview here - Farkas (1985); Villalta (2008); Quer (2009); Portner and Rubinstein (2013), and Giannakidou (2006, 2015) for recent overviews; also Smirnova (2012), Giannakidou (1998, 1999, 2006, 2009, 2015) for Greek; Marques (2004) for Brazilian and European Portuguese; Mari (2015) for Italian; Quer (2009) for Catalan and Spanish; Baunaz (2015) for French). The main selection patterns that we find in Romance languages and Greek are as follows.

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[3]See also, outside this school of thought, Giorgi and Pianesi (1996), on parallel suggestions.

[4]Within this line of thought, Mari (2016) also reconsiders the semantics for Italian believe predicates. Cf. *infra*.

(5)   Indicative verbs in Greek

    a. assertives: leo (say), dhiavazo (read), isxirizome (claim)

    b. fiction verbs: onirevome (dream), fandazome (imagine)

    c. epistemics, non-factive: pistevo (believe), nomizo (think)

    d. epistemic factive verbs: ksero, gnorizo (know)

(6)   Indicative verbs in French

    a. assertives: dire (say), lire (read), soutenir (claim)

    b. fiction verbs: rêver (dream), imaginer (imagine)

    c. epistemics, non-factive: croire (believe), penser (think)

    d. epistemic factive verbs: savoir (know)

Italian behaves like French and Greek, with the exception of *belief* predicates. In the rest of European languages, as well as Turkish (Sarigul 2015), complements of belief and fiction verbs behave like complements of knowledge verbs: they select indicative.

In Greek, we have a system of complementizer particles: *na* is for subjunctive, *oti, pu* for indicative. The subjunctive particle *na* precedes the tensed verb, but the indicative is unmarked in main clauses, i.e. past tenses (simple past, imperfective past, perfect tenses) and the present are indicative. In embedded clauses the indicative particle *oti* is used. For emotives, we have the indicative complementizer *pu*:

(7)   a.   Thelo   na/*oti   kerdisi   o Janis.
            want.1sg SUBJ/IND win.NONPAST.3SG the John.
            I want John to win.

     b.   O Pavlos {kseri/pistevi} oti/*pu/ *na efije i Roxani.
            'Paul knows/believes that Roxanne left.'

(8)   O Pavlos lipate {*pu/*oti/*na*} diavase afto to vivlio.
     Paul regrets that he read this book.

Pu follows emotive verbs (Varlokosta 1994, Giannakidou 2015), but also memory verbs such as *thimame* 'remember', and occasionally *ksero* 'know'. Giannakidou (*ibid.*) claims that it also has expressive content. Here, we will propose that *pu* is sensitive to veridicality in the presupposition. *Na* is typically followed by the form glossed above as NONPAST, which itself is licensed - Giannakidou (2009) treats it as a temporal polarity item. NONPAST only appears with *na*, the future particle, and other nonveridical particles. It is the form that gives future orientation (Giannakidou 2009, Giannakidou and Mari 2015b).

The indicative pattern is challenging for the traditional view that the indicative implies that the sentence is 'true in the actual world', because complements of belief, fiction, and assertive verbs are not true in this sense. Of the indicative complements, only complements of *know* are true of the actual world, but the grammar of mood selection appears to make no distinction between actual and imagined or believed truth. This motivates the notion of subjective veridicality that we discuss in the next section– and which, we will argue, underlies emotive verbs.

Verbs selecting subjunctive belong to the following classes.

(9)   Subjunctive verbs in Greek

   a. volitionals: thelo (want), skopevo (plan)

   b. directives: dhiatazo (order), simvulevo (advise), protino (suggest)

   c. modal verbs: prepi (must), bori (may)

   d. permissives: epitrepo (allow); apagorevo (forbid)

(10) Subjunctive verbs in Italian

   a. volitionals: volere (want),

   b. directives: ordina (order), consiglia (suggest)

   c. modal verbs: necessario (must), posssibile (may), bisogna (must).

   d. permissives: impedisce (forbid)

   e. emotives: essere sorpreso (be surprised), essere irritato (be irritated)

   f. epistemic: credere (believe), pensare (think), essere cosciente (be aware), essere convinto (be convinced)

Note that, in Italian both emotives and epistemic predicates (but *sapere* (know)) are subjunctive selectors in Italian. We do not raise here the question of belief verbs (Mari 2016). Here we study *essere cosciente*.

Empirically, it is also important to note that some verbs are compatible with both moods. *Elpizo/sperare* (hope) is one such verb in Greek and Italian.

(11) a. Elpizo   na/oti   kerdise   o Janis.
          hope.1SG that.SUBJ/IND win.PAST.3SG the John.
          I hope that John won.

      b. Spero   che Gianni abbia   vinto.
          Hope.1SG.PRES that John   have.3SG.SUBJ won.
          I hope that John has won.

Equivalents of 'hope' are also flexible in other languages, as argued by Portner and Rubinstein (2013) and Anand and Hacquard (2013). We argue here that the different choice reflects sensitivity of the mood morphemes to the (non)veridicality of assertion and presupposition. Let us finally note that some emotives in Italian are also compatible with the indicative.

(12)   Sono   contento che tu   sia/sei   qui.
       Be.1SG.PRES happy   that you be.2SG.SUBJ/be.2SG.IND here.

       I am happy that you are here.

This shows again that a simple generalization, even for one verb class, is not tenable. We need a more flexible account of the verb meaning, by distinguishing the presupposition vs. the assertion, and allow for mixed cases, i.e. veridicality on one level and nonveridicality on the other. But first let's lay out the basic framework.

3. Veridicality and Nonveridicality: objective and subjective

The initial definition of veridicality is for natural language expressions (here, *functions* F), in terms of entailment such that F is veridical if it entails the truth of its complement p:

(13)   Objective veridicality and nonveridicality (Zwarts 1995, Giannakidou 1998).
       Let F be a monadic sentential operator. The following statements hold: F is veridical just
       in case $Fp \to p$ is logically valid; if this does not hold, F is *nonveridical*.

Here, nonveridicality is the absence of truth entailment. A factive verb such as *know* is objectively veridical: If *i knows p* is true (where i stands for the attitude holder), then p is also true. But *i wants p* , under normal circumstances, does not entail p, therefore *want* is objectively non-veridical.

However, we do have to explain why *believe* and *dream* verbs select the indicative in an overwhelmingly large number of languages. For this, we need the notion of *subjective* veridicality. Subjective veridicality is also on inference of truth, but it is *doxastic*, i.e. now veridicality is relativized with respect to an *individual anchor i*, and what i believes. In embedded clauses, the crucial anchor is the bearer of the attitude. Giannakidou defined *models of evaluation* M to describe the belief states of individual anchors. These models are sets of worlds, relative to i, corresponding to what i knows or believes. We can call those models now epistemic states.

(14)   *Epistemic state of an individual anchor i*
       An epistemic state $M(i)$ is a set of worlds associated with an individual i representing
       worlds compatible with what i knows or believes.

Given M, we can now identify (non)veridicality subjectively as follows:

(15)   *Subjective veridicality*
       A function F with a proposition p as its argument is subjectively veridical with respect to
       an individual anchor i and an epistemic state $M(i)$ iff:
       $\forall w[w \in M(i)p(w')]$.

This reflects the classical (Hintikka 1962) treatment of belief[5]. Given M, we can now identify
veridicality of propositional attitudes as follows:

(16)   A propositional attitude predicate ($PA_{<st,<e,st>>}$) is **subjectively veridical** wrt its individ-
       ual $<e>$ argument (the *individual anchor i*) and $M(i)$ iff $\forall w[w \in M(i) : p(w)]$.

Believe and fiction Pas are subjectively, but not objectively, veridical because their main clause
subject (the believer or dreamer) is in an epistemic state that fully supports p, regardless of whether
p is actually true. Here we define *Support* as universal quantification over the entire epistemic state:

(17)   *Support of a proposition p in an epistemic state* M.
       a. A non-empty epistemic state $M(i)$ of an individual anchor i supports a proposition p
           iff all worlds in $M(i)$ are p-worlds.
       b. Epistemic states that support p are veridical.

Importantly, subjective veridicality is Hintikkean belief, and does not entail objective veridicality.

A subjectively nonveridical function, on the other hand, imposes non-homogeneity on the epis-
temic state: there is at least one $\neg p$ world, and M is partitioned into a p-supporting and non-
supporting space (where p is not true):

(18)   *Subjective nonveridicality*
       A function F with a proposition p as its argument is subjectively nonveridical with respect
       to an individual anchor i an epistemic state $M(i)$ iff:
       $\exists w' \in M(i) : \neg p(w') \wedge \exists w'' \in M(i) : p(w'')$.

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[5]See for a discussion about different uses of *credere* (belief) in Italian and a rethinking of the classical entry,
see (Mari 2015). Mari proposes that belief predicates articulate an epistemic and a doxastic dimensions, and that
they convey that the attitude holder 'does not know' at the non at issue level. She also offers a new analysis for the
indicative/subjunctive variation under negation.

(19)   A propositional attitude predicate ($PA_{<st,<e,st>>}$) is **subjectively nonveridical** wrt M(i) iff $\exists w \in$M(i) : $\neg p(w) \wedge \exists w' \in$M($i$) : $p(w')$.

Subjective nonveridicality thus means M(i) as a whole does not support p: some worlds in $M(i)$ support p and some others don't. This immediately suggests a link between uncertainty operators and the subjunctive selecting verbs (e.g. modals, volitionals) and subjective nonveridicality.

From the epistemic domain, we can move to generalize veridicality and nonveridicality to modal spaces (sets of worlds) in general, including various kinds of modal bases for modals (Giannakidou and Mari 2015b). From the perspective of factives, we define the factive space as objectively veridical follows, where w_0 is the actual world.

(20)   *Objectively veridical, factive space*
       The singleton set of worlds M $= \{w_0\}$ is *objectively veridical* with respect to a proposition p iff $\{w_0\} \in p$.

We will use this for *know*, and simply write $w_0 \in p$. On the assumption that the future is open, one can define metaphysical modal bases as objectively *non*veridical, assuming a branching time model with a fixed past and present and an open future. This is needed future oriented attitudes, but we cannot expand more here.

4. Presupposition vs. assertion in the factive class

Subjective veridicality indicates that the anchor i knows or believes p; subjective nonveridicality, on the other hand, indicates that i does not know or believe p. For the indicative after belief verbs, subjective veridicality is crucial.

Following classic treatments of belief, for the evaluation of p in 'i believes that p', it must be the case that some relevant M(i) fully supports p. Because we have third person belief, there are two potential anchors i: the speaker and the main clause subject. Their epistemic spaces need not coincide: the speaker need not believe that p is true, but for the sentence to be true the believer cannot have any $\neg p$ worlds in her belief space.[6]

(21)   O   Nicholas pistevi   oti/*na efije   i   Ariadne.
       the Nicholas believe.3SG that.IND left.3SG the Ariadne.
       Nicholas believes that Ariadne left.

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[6]Selection of the subjunctive in Italian with belief verbs is sensitive to shifts across epistemic anchors see Quer (1998), see also discussion in Mari (2015).

(22)   [[Nicholas believes that p]] is true in w with respect to $\mathrm{M}(Nicholas)$ iff:
       $\forall w'[w' \in \mathrm{M}(Nicholas)p(w')]$

Since all worlds in $\mathrm{M}(Nicholas)$ being p-worlds is a truth condition for belief, the *belief* verb is subjectively veridical. Because $\mathrm{M}(Nicholas)$ is a doxastic space, $\mathrm{M}(Nicholas)$ does not make reference to the actual world w, and it does not guarantee that w is a p world.

Subjective veridicality, as a notional category, covers also fiction verbs such as *dream*. In this case, we understand M to be the set of worlds compatible with the subject's dream (which we note M_{dream}) (from now on, unless otherwise stated, $\mathrm{M}(i)$, stands for $\mathrm{M}_{epistemic}(i)$).

(23)   a. O Nicholas onireftike oti   efije   i   Ariadne.
           the Nicholas dreamt.3SG that.IND left.3SG the Ariadne.

       b. Nicholas ha sognato che Ariadne era   andata via.
           Nicholas has dreamt that Ariadne be.3SG.IMPERF.IND gone   away.
           Nicholas dreamt that Ariadne left.

(24)   [[Nicholas dreamt that p]]$^{w, M_{dream}(Nicholas)}$ is 1 iff:
       $\forall w'[w' \in \mathrm{M}_{dream}(Nicholas)p(w')]$

When I dream or imagine something, the spaces are 'private' (Giorgi and Pianesi 1996) and do not entail anything about the real world.[7] My dream state fully supports p, it is therefore veridical. We can understand all context shifting verbs, including verbs of reported speech, to be likewise subjectively veridical (Giannakidou 1998,1999), hence it is no surprise that they select indicative.

The belief and dream class, in the languages that select the indicative, appear to have no presupposition. Note that this is not the case for Italian belief that opts for subjunctive (Mari 2016). Now let's consider emotive verbs. These do have a presuppositional layer, but contrary to the usual wisdom, emotives do *not* have a presupposition of objective veridicality, but of subjective veridicality (Egré 2008).

(25)   Falsely believing that he had inflicted a fatal wound, Oedipus regretted killing the stranger
       on the road to Thebes (Klein 1975).

This shows that one can have an emotive attitude towards something that one *believes* to be a fact, but may actually *not* be a fact. Hence, the presupposition of emotive verbs is not of objective veridicality, but of subjective veridicality:

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[7]Note that 'privacy' is a subjunctive trigger for Giorgi and Pianesi (1996) and it is specifically and only used for *credere* (believe).

(26)   Subjective veridicality presupposition of emotives
$[[i \text{ V-emotive that } p]]^{w,M(i)}$ is defined iff:
$\forall w'[w' \in M(i) \ p(w')]$.

The presupposition of *know*, on the other hand, is objective veridicality:

(27) $[[i \text{ knows that } p]]^{w_0,M(i)}$ is defined iff $w_0 \in p$.
If defined $[[i \text{ knows that } p]]^{w,M(i)} = 1$ iff:
$\forall w'[w' \in M(i)p(w')]$

This lexical entry captures the factivitity of *know* as presupposition of objective veridicality, while at the same time distinguishing *know* from emotive verbs where the presupposition is merely belief of i that p without entailing or presupposing anything about the real world. *Know* is veridical in both the presupposition and the assertion.[8]

Emotives are a mixed case: they have a presupposition of subjective veridicality (see 26), and an assertion that is nonveridical, as we now show.

5. Emotives and nonveridicality

Because of NPI-licensing and Baker's earlier observations, it has often been claimed that emotives carry and implicature (Linebarger 1987) or something 'stronger' Giannakidou (2006). We give below Giannakidou's version of the presupposition Giannakidou (2015): i is surprised that p is defined if only if: i believed that $\neg p$, at a time t' $\prec t_u$ (where t_u is the utterance time). A similar idea is also found in Giorgi and Pianesi (1996), where a counterfactual presupposition is advocated. From this perspective, the emotive verb is again mixed: nonveridical in the presupposition, while being veridical in the assertion. We can therefore parametrize languages such that the Greek-type allows the subjunctive only with logically (i.e. in the assertion) nonveridical verbs. Italian subjunctive, on the other hand, is an NPI triggered by negation at the non-assertion (e.g. like *any* in *I am surprised he has any friends*).

The negative presupposition account, however, faces a challenge with the following example. Observe the continuation 'and she always knew that' in 5.

(28)   Arianna è contenta/felice/triste/irritata/ . . . che Nicolas abbia   partecipato alla
       Arianna is happy/glad/sad/irritated/   . . . that Nicholas has.3SG.SUBJ participate to-the
       maratona, e ha sempre saputo che lo avrebbe   fatto.
       marathon, and has always known that that have.3SG.COND done.

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[8]*Know* is considered to be like *believe* in the assertion, with a veridical presupposition.

> Arianna is happy that Nicholas participate in the marathon, and she always knew that he would do it.

(28) clearly does not convey that the speaker has an expectation or belief that $\neg p$; and there is a contrast with *surprise* (*I am surprised that John participated in the marathon, and I always knew that he would do it*), thus preventing a general characterization of the emotive class in terms of a negative presupposition. At best, it appears to be an implicature, highly sensitive to the lexical choice of the verb.We propose that emotives have a presupposition of subjective veridicality, as we just suggested, but their assertion is nonveridical because of their **scalar, gradable nature**.

No attention has been paid in the literature to the fact that emotives are gradable predicates, but we will take this as our starting point. Gradability is diagnosed by number of tests (Kennedy 2007, Giannakidou and Mari 2015a).

In all analyses of gradability, gradable predicates introduce degree scales and map individuals onto points on the scales. The scales are assumed to contain a designated degree that functions as a *threshold* (Kennedy 2007) between the positive extent of the scale and the negative extent. For instance, if I say *John is tall*, I am saying that John exceeds the degree d that is the threshold/standard of what counts as tall in the context. If John's height maps onto a degree d' below d, then John cannot be said to be tall, he is not-tall. Let $\mathcal{D}$ be a set of ordered degrees, and $\mathcal{I}$ a set of individuals. We assume that a scalar predicate has the analysis in 5:

(29) $\lambda P.\lambda x.\lambda d.P(x) \geqslant d$

Variables x and d take their value in the sets $\mathcal{I}$ and $\mathcal{D}$. Given the threshold d, two equivalence classes are determined: one above d in which i has the sentiment, and one in which i does not have it (below d). We are now going to map scales into modal spaces triggered by propositional attitudes. We propose that there is a morphism $\mathcal{H}$ from degrees $\mathcal{D}$ and individuals $\mathcal{I}$ to worlds.

(30) $\mathcal{H}(\mathcal{D})(\mathcal{I}) = W$

The modal base that we obtain via this mapping is non-homogeneous.[9],[10] The worlds in the modal base are partitioned into those in which i has the emotion and those in which she does not. This partition is driven by the threshold d. Note (see Figure 1), that the worlds in which i has the sentiment, p is true. In other worlds, W is a set of worlds ordered by $\leqslant_{\mathcal{S}_i}$. Viewing $\leqslant_{\mathcal{S}_i}$ as the

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[9]Klecha (2014) proposes an account of gradable modal adjectives like *important* that incorporates degrees into the denotation of the adjectives, combining a degree-based semantics and ordering sources à la Kratzer. Here we propose an analysis of scalar emotive predicates in modal terms ,

[10]On emotivity and non-veridicality, see also Beltrama (2015).

singleton set p, we see that just like with the scale, the set of worlds is partitioned into two equivalence classes of worlds. One is the set of worlds in which the attitude holder has the sentiment and p is true. The other one is the set of worlds in which the attitude holder does not has the sentiment and p is false.
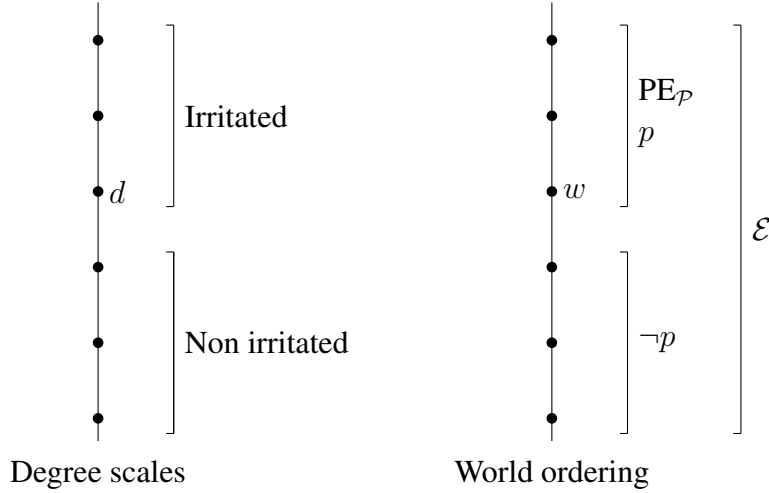

Figure 1: The non-veridical space of emotivity

This partitioning allows us to define *Positive-Extent-worlds* (PE) for p:

(31) $\text{PE}_{\mathcal{P}} = \{w' \in \mathcal{E}_{\mathcal{P}} : w'$ where the propositions in $\mathcal{P}$ are true $\}$

Here, the set $\mathcal{P}$ is the singleton set $\{p\}$. So $\text{PE}_{\mathcal{P}}$ contains all the worlds in which p is true. In $\text{PE}_{\mathcal{P}}$ i has sentiment $\mathcal{S}$. But not all worlds in $\mathcal{E}$ are PE worlds for p, $\mathcal{E}$ only partially supports p. $\text{PE}_{\mathcal{P}}$ is a subset of $\mathcal{E}$ (the emotive space). The complement of $\text{PE}_{\mathcal{P}}$ contains $\neg p$ worlds. The semantics we propose here may remind the reader of the Best ordering used for modals (Portner 2009, Giannakidou and Mari 2015b), but our ordering source merely contains p.

Hence, the gradability of the emotive predicate triggers a modal space $\mathcal{E}$, and partitions it into p and $\neg p$ worlds. The emotive space is thus a nonveridical space. Now that we have the semantics for the emotive component, let us put it together with the presupposition, and provide our lexical entry for emotives.

(32) $[[i \text{ V-emotive } p]]^{w,M(i)}$
     a. is defined iff $\forall w'[w' \in M(i)p(w'')]$ (subjective veridicality)
     b. If defined, $[[i \text{ V-emotive} p]]^{w,M(i)} = 1$ iff $\forall w'' \in \text{PE}_{\mathcal{P}}(\mathcal{E})(p(w''))$

$\mathcal{E}$ is a nonveridical space containing supporting worlds, but also non-supporting worlds: i.e. $\exists w' \in \text{PE}_{\mathcal{P}} : \neg p(w')$. This lexical entry indicates that M(i) is relevant for the presupposition of emotives, but in the assertion they work like modals, in triggering the modal base of emotion. Let us go back to the predicates of awareness now.

In Greek, in contrast to Italian, awareness verbs select indicative, aligning with belief and imagination verbs. We assume that M_{con} is a type of belief space.

(33)   Awareness in Greek
        $[[i \text{ exi-epignosi that } p]]^{w_0, M(i)}$ is defined iff $w_0 \in p$.
        If defined $[[i \text{ exi-epignosi that } p]]^{w, M(i)} = 1$ iff:
        $\forall w'' \in \text{M}_{con}(i)(p(w''))$

(34)   O Nicholas exei epignosi oti/*na i Ariadne tou leei psemata.
        the Nicholas has awareness that.IND/*SUBJ the Ariadne him says lies
        Nicholas is aware that Ariadne is lying to him.

Importantly, epistemic *be aware* can also be understood as gradable, and that would explain why it selects the subjunctive in Italian:

(35)   È molto/poco cosciente che tu sia stanco.

        He is very/little aware that you are tired.

(36)   Maria è più cosciente di Gianni dell'accaduto.

        Maria is more aware of Gianni of what has happened.'

Importantly, epistemic be be aware can also be understood as gradable, and that would explain why it selects the subjunctive in Italian. The space for *essere cosciente* now is M_{con}, just like in Greek, but this space is conceptualized as gradable, and thus partioned into positive extent (PE) and negative extent, just like with emotives.

(37)   Awareness in Italian.
        $[[i \text{ è cosciente that } p]]^{w_0, M(i)}$ is defined iff $w_0 \in p$.
        If defined $[[i \text{ è cosciente that } p]]^{w, M(i)} = 1$ iff:
        $\forall w'' \in \text{PE}_{\mathcal{P}}(\text{M}_{con})(i)(p(w''))$

(38)   Sono cosciente che Anna /sia a casa.
        Be.1SG.PRES.IND aware that Anna be.3SG.IND.SUBJ at home.
        I am aware that Ann is home.

For Italian, the assertion of 'be aware' will be like that of the emotive, dividing the awareness space between p and $\neg p$ worlds, thereby producing nonveridicality as reflected in the choice of the subjunctive. We see that the space of 'awareness' (M_{con}) is conceptualized a partitioned one, including worlds of awareness and worlds of non-awareness Awareness worlds (the Positive Extent $PE_{\mathcal{P}}$) are p worlds. We see that awareness is lexicalized along the pattern of emotivity. Moreover, the same verb category 'be aware' lexicalizes differently in Greek and Italian justifying different moods (in our implementation M_{con} is not partitioned in Greek and partitioned in Italian). Since the consciousness predicate can be a subjunctive selector, gradability per se is not the key in determining mood; *pace* Villalta (2008), but offers the necessary structure for nonveridicality by providing a threshold for p and $\neg p$ worlds that mirrors the positive and negative extent of the scale. The connection between evaluating (via a gradable space) and nonveridicality has broader applications, as seen also in recent work by Beltrama (2015).

To the question why is it that Greek lexicalizes 'be aware' as a belief verb and Italian lexicalizes it as an emotive, we answer that this is due to a prototypicality effect. Note that in Italian belief verbs do not behave like in Greek, and are subjunctive selectors. There is thus no prototypical indicative belief verb that sets the standard for indicative selecting predicates, in Italian. Rather, belief verbs in Italian set the standard for subjunctive along with emotive predicates. Languages thus seem to choose among possible lexicalizations those that better align with the general pattern set by prototypical cases.

We consider, finally, the role of the mood particles. As we said at the beginning, and following our more expanded account in Giannakidou and Mari (2015b), we take it that the mood morphemes are polarity like elements that have definedness conditions that make reference to (non)veridicality, like all polarity items.

6. An OT analysis

To capture cross-linguistic and intra-linguistic variation we use an optimality theoretic system (Hendriks and de Hoop 2001, de Swart 2010).[11] We provide definedness conditions for the subjunctive and the indicative in Italian and Greek. Recall that *PA* stands for 'Propositional Attitude' verbs.

(39)   a. **Ind/Veridicality (Ind/+Ver)**: Indicative is defined only in the immediate scope of a *PA* that is veridical (i.e. in the assertion or the presupposition).

      b. **Subj/NonVeridicality (Subj/-Ver)**: Subjunctive is defined only in the scope of a *PA* that is nonveridical (i.e. in the assertion or in the presupposition).

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[11]Farkas (2013) also proposes an OT based analysis of flexible mood patters. Farkas proposes that +assertion triggers the indicative and -assertion triggers the subjunctive. We do not use ±assertion here, which seems to stumble over mood choice in questions. Our theory is limited to embedded mood patterns. For further discussion, see Giannakidou and Mari (2015c).

So a PA has two dimension of meaning and can be both veridical and non-veridical (emotives, Italian *consciente*). To these constraints, we add a presupposition constraint for Greek *pu*, and a factivity constraint on the Greek subjunctive particle *na*.

(40) a. *pu*/PRESP:**+Ver**: If *pu*-IND appears, then *PA* has a veridical presupposition.
      b. ***SubjFactive**: If *na*-SUBJ appears, then *PA* is nonfactive.

Italian and Greek also pattern differently with regard to ranking. Greek favors veridicality; Italian is more tolerant, and although subjunctive is strongly preferred, the indicative is not entirely blocked. Hence we treat the Italian constraints as standing in free variation in an OT framework, but the Greek constraints are ranked:

(41) a. Unranked in Italian: {Ind/Veridicality, Subj/NonVeridicality}
      b. Greek ranking: {*pu*/PRESP:**+Ver**, *SubjFactive } > { Ind/Veridicality, Subj/NonVeridicality}

We consider the non-blocking preference for the subjunctive as a supplementary felicity constraint which does not affect grammaticality, and hypothesize that Italian is moving from a nonveridicality-wins type of language to a more neutral one. (Ultimately, Italian is on a path of becoming an indicative preferring language like French in the Romance group).

Back to *emotives*. In Italian, both the indicative and the subjunctive violate a constraint. Since there is no ranking, both variants are licensed in Italian.

rimpiagnere[PRESUPP:+Ver, ASSERTION:-Ver] $\left[_{CP} \ldots \text{MOOD:}_{--}\right]$	Ind/+Ver : Subj/-Ver
⇒ MOOD:Ind	:
⇒ MOOD:Subj	:

In Italian, the subjunctive is preferred in virtue of a non-blocking preference, which, as we just said, we consider a felicity condition.

With Greek emotives-factives, *pu* is the winner because it is the designated form for PRESUPP:+Ver. The subjunctive is blocked by the factivity constraint (12b). ('pr' stands for 'presupposition'; 'as' for assertion).

lipame[pr:+Ver, as:-Ver] $\left[_{CP} .. \text{MOOD:}_{--}\right]$	*pu*/PR:+Ver :	*SubjFactive	Ind/+Ver :	Subj/-Ver
a. MOOD:Ind *oti*	:	*!	:	
b. MOOD:Subj	:	*!	:	
c. ⇒ MOOD:Ind *pu*	:		:	

Regarding *pu*, it is indeed quite remarkable that a language has a form sensitive to presupposition only. *Pu* appears to be like a positive polarity item 'PPI': it ignores the nonveridicality of the assertion, and gets licensed by the veridicality of the presupposition. The fact that it is triggered by a property of non-assertion is in line with observations in the literature, for instance about the German Konjunktiv that it contributes itself conventional implicature (Potts 2005) and about *pu* itself that it has expressive content (Giannakidou 2015).

Overall, this system predicts the correct patterns of variation across languages depending on the definedness condition of moods, the two tier semantics of verbs, and whether the constraints are ranked or not. As far we can tell, our system fares better than any of the other accounts of mood currently available. Space prevents us from elaborating further, which is something we want to do in future work.

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Semantic consequences of syntactic subject licensing: Aspectual predicates and concealed modality[1]

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Abstract. Across a typologically diverse range of languages, aspectual verbs like *begin* and *continue* uniformly accept controlled complements (e.g., *Kim began to open the door*) but reject overt-subject complements (e.g., **Kim began for Sandy to open the door*). This paper explains this pattern by assigning more meaning to the complement clause than is typically assumed, couched in Kratzer's (2006) decompositional approach to attitude predicates and drawing on a long tradition of work on the semantics of infinitives. In particular, I propose that the licensing of overt subjects in *for-to* complements (and their cross-linguistic kin such as Greek subjunctives) involves a covert modal whose flavor renders such complements semantically incompatible with aspectual verbs.

Keywords: control, attitudes, modality, embedding, aspectual verbs

1. Introduction

By definition, complement control involves a syntactic configuration in which a single overtly expressed argument binds two distinct participant roles, one associated with the embedding predicate and one associated with the subject position of the embedded constituent. In all of the sentences in (1), for example, *Kim* names both the attitude-holder associated with the (bolded) matrix attitude predicate as well as the unexpressed subject of the (bracketed) embedded constituent.

(1) a. Kim **wanted** [to read the book].
    b. Kim **was glad** [to leave].
    c. Kim **regretted** [leaving].
    d. Kim **wondered** [how to help].
    e. Kim **claimed** [to be an expert].

Given the distinctness of the two participant roles that are tied together in a control configuration, it should come as no surprise that a great many control sentences have non-control variants in which each of the two relevant participant roles is linked to its own unique, overtly expressed argument. The sentences in (1), for example, can all be manipulated to yield the variants in (2), where, with various kinds of syntactic adjustments, it is possible to supply the embedded constituent with its own referentially independent subject, in this case *Sandy*.

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(2)   a. Kim **wanted** [Sandy to read the book].

       b. Kim **was glad** [for Sandy to leave].

       c. Kim **regretted** [Sandy leaving].

       d. Kim **wondered** [how Sandy could help].

       e. Kim **claimed** [that Sandy was an expert].

The starting point for this paper is the observation that not all control predicates participate in this kind of alternation. In particular, there are at least three kinds of control predicates that resist a non-control syntax to one degree or another. First, there is a class of subject-control predicates including *try* and *decide* which have to do with naming a commitment on the part of the attitude-holder to carry out some action (what Sag and Pollard 1991 call *promise*-type verbs), as in (3). Even more marginal with overt embedded subjects are object-control predicates, such as *persuade* and *beg*, as illustrated in (4). Finally, aspectual predicates like *begin* and *continue* robustly reject overt embedded subjects, as illustrated in (5).

(3)   a. Kim **tried** [(?for Sandy) to sing].

       b. Kim **decided** [(?for Sandy) to sing].

(4)   a. Kim **persuaded** Sandy [(??for Bill) to sing].

       b. Kim **begged** Sandy [(??for Bill) to sing].

(5)   a. Kim **began** [(*for Sandy) to sing].

       b. Kim **continued** [(*for Sandy) to sing].

The focus of this paper is specifically on the aspectual verbs: Why do aspectual verbs disallow non-controlled/overt-subject complements? In a nutshell, the answer that I will propose is that we need to pay careful attention to what it is that licenses an overt subject. In English, the complementizer *for* syntactically licenses an overt subject in an infinitive, but, I argue, this complementizer contributes a modal semantics that renders it incompatible with aspectual verbs.

The proposed analysis intersects with at least three themes that are of broader significance than the specific puzzle in (5). First, it provides support for a Kratzer-style decompositional approach to embedding (Kratzer, 2006, 2013; Moulton, 2009, 2015; Bogal-Allbritten, 2016) and synthesizes this approach with an independently long tradition of work on the semantics of infinitives (see especially Bresnan 1972; Stowell 1982; Pesetsky 1992; Portner 1997; Bhatt 1999). Second, the analysis has repercussions for the debate over whether some kinds of aspect have a modal dimension. If the analysis in this paper is on the right track, then aspectual verbs, and possibly the grammatical category of aspect more generally, are either not modal at all or at the very least involve some kind of modality importantly different from (other kinds of) root modality. Finally, a third general theme of this paper has to do with the utility of shifting some of the explanatory

burden of complementation facts off the syntax proper and onto principles of interpretive semantics. To the extent that all of the semantic pieces are independently motivated, we can simplify our theory of syntax by letting it generate certain kinds of deviant sentences, since the deviance is fully predicted by the semantic component alone.

The organization of the rest of the paper is as follows. In section 2, I provide some justification for singling out aspectual verbs to the exclusion of other control verbs that resist overt embedded subjects. In section 3, I show that a raising-only analysis of aspectual verbs, while initially an appealing explanation for the puzzle, ultimately fails. Section 4 turns to the semantics of *for-to* infinitives and argues that they have a modal component, and in section 5, I implement the analysis in a Kratzer-style decompositional approach to embedding. Section 6 then shows how the analysis helps to make sense of the aspectual verb data, and section 7 offers some remarks on how the analysis might scale up to make sense of other complementation facts both in English and in other languages. Finally, section 8 concludes.

2. Some justification for singling out aspectual verbs

As already noted, aspectual verbs like *begin* are not the only kind of control verbs that resist overt embedded subjects; *try* is another familiar example of such a verb. But *try* differs from *begin* along at least three dimensions. The first has to do with degree of unacceptability: (6) is marginally acceptable whereas (7) is fully unacceptable.

(6)   Kim **tried** (?for Sandy) to sing.

(7)   Kim **began** (*for Sandy) to sing.

The second has to do with interpretability. To the extent that it is acceptable, (6) is interpretable along the lines suggested by (8), whereby the matrix subject is understood to play a causal role in effecting the outcome named by the complement. (See also Perlmutter 1968; Jackendoff and Culicover 2003; Grano 2015, 2016, who make a similar observation about *intend*.) By contrast, (7) has no coherent interpretation; as shown in (9), it cannot be interpreted using the strategy that works for *try*.

(8)   Kim **tried** for Sandy to sing.
       ≈ Kim tried *to bring it about that* Sandy sing.

(9)   Kim **began** for Sandy to sing.
       ≠ Kim began *to bring it about that* Sandy sing.

Finally, the third difference has to do with cross-linguistic uniformity. In some languages, such as Greek, and in some dialects of English (Henry, 1995), overt embedded subjects under *try* are

reported to be fully acceptable, whereas this is not the case for *begin*. In languages as typologically far removed from each other as Mandarin Chinese (10) and Greek (11), overt embedded subjects are ungrammatical under *begin*.

(10) Zhangsan kaishi (*Lisi) kai   men.
      Zhangsan begin Lisi   open door
      'Zhangsan began (*for Lisi) to open the door.'   MANDARIN CHINESE

(11) O Yanis arxise na   anoigi tin porta (*i Maria).
      the Yanis began SBJV opens the door the Maria
      'Yanis began (*for Maria) to open the door.'   GREEK

Table 1, taken from Grano 2015, summarizes the acceptability of overt embedded subjects for three verbs across six languages. In the case of 'want', an overt embedded subject is always acceptable, as long as the syntax of the language is respected. By contrast, 'try' exhibits variable acceptability, and 'begin' exhibits uniform unacceptability.

	English	French	Mandarin	Greek	Hebrew	Spanish
want	✓	✓	✓	✓	✓	✓
try	%	*	*	✓	✓	✓
begin	*	*	*	*	*	*

Table 1: Crosslinguistic availability of overt embedded subjects (taken from Grano 2015)

Taken together, these three considerations suggest that the deviance of overt embedded subjects under aspectual verbs has a different source from that of the (marginal) deviance of overt embedded subjects under verbs like *try*. In what follows, I focus exclusively on aspectual verbs.

3. Against a raising-only explanation for the puzzle

Data like (12) show that aspectual verbs can be used as raising predicates; i.e., there is not always a thematic dependency between the aspectual predicate and its subject. The subject can be expletive *it* (12a) or expletive *there* (12b) or an idiom chunk (12c).

(12) a. It began to rain.
      b. There continued to be trouble.
      c. The shit started to hit the fan.

If aspectual verbs were *always* raising predicates (as argued by, e.g., Rochette 1999), then their incompatibility with overt-subject complements (i.e., the central puzzle of this paper) would be

fully expected and predicted and not actually a puzzle at all. In a sentence like (13), *Sandy* binds the participant role associated with embedded predicate *sing*, and on a raising analysis of *begin*, there would be no participant role for the matrix subject *Kim* to bind, thereby resulting in grammatical deviance.

(13)   *Kim began for Sandy to sing.

In what follows, however, I show that a raising-only analysis of aspectual verbs is untenable, following Perlmutter (1970); Landau (2013). In particular, aspectual verbs pattern like control predicates and unlike raising predicates with respect to a number of properties.

The first relevant property is complement drop. Jacobson (1992) generalized that whereas some control predicates can appear without a complement if the context supports recovery of the missing material, raising predicates can never do this. As observed by Landau (2013) (see also Perlmutter 1970 for a similar observation), aspectual verbs pattern like control verbs and unlike raising verbs in admitting complement drop. This is illustrated in (14)–(16). (14) shows that some but not all control predicates admit complement drop: *try*, *promise*, and *refuse* do whereas *want* does not. (15) shows that raising predicates do not. Crucially, (16) shows that aspectual verbs pattern like control verbs in admitting complement drop.

(14)   CONTROL
    a. Kim {tried / promised / refused} to read the book but I don't think Sandy {tried / promised / refused}.
    b. *Kim wanted read the book but I don't think Sandy wanted.

(15)   RAISING
    a. *Kim happened to read the book but I don't think Sandy happened.
    b. *Kim wound up reading the book but I don't think Sandy wound up.
    c. *Kim {seemed / appeared} to be happy but I don't think Sandy {seemed / appeared}.
    d. *Kim turned out to need surgery but I don't think Sandy turned out.
    e. *Kim grew to love Beethoven but I don't think Sandy grew.

(16)   ASPECTUAL
    a. Kim {started / began / continued} to read the book but I don't think Sandy {started / began / continued}.
    b. Kim {stopped / finished} reading the book but I don't think Sandy {stopped / finished}.

The remaining properties all relate to agent-sensitivity: there are a number of syntactic configurations that only support predicates that bear an agentive thematic relation to their subject. If a predicate is comfortable in such a configuration it means that it bears an agentive thematic relation

to its subject, so we expect (agentive) control predicates to be possible in such configurations, but not raising predicates, which by definition bear no thematic relation at all with their subject.

The first two examples of this are both due to Perlmutter (1970): control (17) but not raising predicates (18) can be used to form imperatives, and aspectual verbs pattern with control verbs here (19).

(17) CONTROL
  a. {Try / Promise} to read the book!
  b. Refuse to help them!
  c. Decide to be great!

(18) RAISING
  a. *Happen to read the book!
  b. *Wind up reading the book!
  c. ?Grow to love Beethoven!

(19) ASPECTUAL
  a. {Start / Begin / Continue} to read the book!
  b. {Stop / Finish} reading the book!

Second, as also observed by Perlmutter (1970), control (20) but not raising predicates (21) can be embedded under *persuade*, and here again aspectual verbs pattern with control verbs (22).

(20) CONTROL
  a. Kim persuaded Sandy to {try / promise / refuse / decide} to read the book.
  b. Kim persuaded Sandy to decide to be great.

(21) RAISING
  a. *Kim persuaded Sandy to happen to read the book.
  b. *Kim persuaded Sandy to wind up reading the book.
  c. ?Kim persuaded Sandy to grow to love Beethoven.
  d. *Kim persuaded Sandy to {seem / tend} to be happy.

(22) ASPECTUAL
  a. Kim persuaded Sandy to {start / begin / continue} to read the book.
  b. Kim persuaded Sandy to {stop / finish} reading the book.

Third, as observed by Landau (2013), control (23) but not raising predicates (24) support VP pseudoclefting, and here as well, aspectual verbs pattern like control predicates (25).

(23)　CONTROL

　　　a.　What Kim did was {try / promise / refuse} to read the book.

　　　b.　What Kim did was decide to be great.

(24)　RAISING

　　　a.　?What Kim did was happen to read the book.

　　　b.　?What Kim did was wind up reading the book.

　　　c.　?What Kim did was grow to love Beethoven.

(25)　ASPECTUAL

　　　a.　What Kim did was {start / begin / continue} to read the book.

　　　b.　What Kim did was {stop / finish} reading the book.

Fourth and finally, control (26) but not raising predicates (27) are compatible with agent-oriented adverbs, and as expected, aspectual verbs pattern like control predicates (28) with respect to this property as well.

(26)　CONTROL

　　　a.　Kim eagerly/reluctantly {tried / promised / refused / decided} to read the book.

　　　b.　Kim eagerly/reluctantly claimed to be happy.

(27)　RAISING

　　　a.　*Kim eagerly/reluctantly happened to read the book.

　　　b.　*Kim eagerly/reluctantly wound up reading the book.

　　　c.　*Kim eagerly/reluctantly grew to love Beethoven.

　　　d.　*Kim eagerly/reluctantly tended to always be late.

(28)　ASPECTUAL

　　　a.　Kim eagerly/reluctantly {started / began / continued} to read the book.

　　　b.　Kim eagerly/reluctantly {stopped / finished} reading the book.

The interim conclusion here is that aspectual verbs are raising/control-ambiguous, and so we cannot explain their resistance to overt-subject complements by appealing to a raising-only analysis. The raising/control ambiguity analysis of aspectual verbs is supported also by cross-linguistic evidence: see Polinsky and Potsdam 2002 on Tsez and Davison 2008 on Hindi.

4. The meaning of *for-to* infinitives

The idea that at least certain classes of infinitives in English have a semantics that distinguish them systematically from finite clauses is not new: work in this vein includes research on complement infinitives (Kiparsky and Kiparsky, 1970; Bresnan, 1972; Carstairs, 1973; Bach, 1977; Stowell,

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1982; Pesetsky, 1992; Portner, 1992, 1997; Barker, 2002) as well as relative infinitives (Kjellmer, 1975; Bhatt, 1999; Hackl and Nissenbaum, 2012) and *too/enough* infinitives (Hacquard, 2005; Nissenbaum and Schwarz, 2008; Marques, 2012).

Bresnan (1972) in particular hypothesizes that *for-to* infinitives express "subjective reason or cause" (p. 80) or "purpose, use, or goal" (p. 81). She furthermore suggests that "[t]he concepts of reason and purpose are semantically related, both implying motivation, and both implying directionality, whether from a source or toward a goal" (p. 81). The purpose- or goal-oriented sense of *for-to* infinitives is found with predicates of desire, commitment, or influence, as in (29). The reason- or cause-oriented sense, on the other hand, is found with emotive factive predicates, evaluative predicates, and predicates that have to do with deontic modality, as in (30).[2]

(29) a. John wanted very much **for** Bill to be a doctor.
      b. John intended **for** Bill to be a doctor.
      c. John demanded **for** Bill to help out.

(30) a. John was thrilled **for** Bill to get an A on the test.
      b. It was stupid **for** Bill to be a doctor.
      c. It was illegal **for** Bill to be a doctor.

With epistemic verbs like *claim* and *believe*, on the other hand, *for-to* infinitives are ruled out, as seen in (31).

(31) a. *John claimed **for** Bill to be a doctor.
      b. *John believed **for** Bill to be a doctor.

The data seen so far seem to fit well with the hypothesis that *for-to* infinitives are acceptable in contexts of PRIORITY modality in the sense of Portner (2009). Portner proposes that modality comes in three main categories as illustrated in (32). Whereas epistemic modality has to do with knowledge, priority modality has to do with "reasons for preferring one situation over another" (Portner 2009:184) and subsumes the more specific subtypes deontic, bouletic, and teleological. The third category, dynamic modality, subsumes both volitional modality and quantificational modality.

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[2]A puzzle associated with infinitival complements to emotive factives is that when the predicate is a verb rather than an adjective, the sentence sounds odd (1a) unless it is construed habitually (1b) or conditionally (1c). See Carstairs 1973; Pesetsky 1992; Portner 1997 for relevant discussion.

(1) a. ??Yesterday John liked **for** Bill to help.
     b. John always liked **for** Bill to help.
     c. John would like **for** Bill to help.

(32) Portner's (2009) classification of modality

    a. *Epistemic*

    b. *Priority*: Deontic, Bouletic, Teleological

    c. *Dynamic*: Volitional [ability, opportunity, dispositional], Quantificational

However, the hypothesis that *for-to* infinitives are restricted to contexts of priority modality is too strong: in the data in (33), we see that *for-to* infinitives are acceptable in contexts that do not involve any kind of ranking of preferences but rather involve classic circumstantial modality or what for Portner would fall under the dynamic category of modality.

(33) a. It was possible **for** hydrangeas to grow here.

    b. It was necessary **for** Bill to sneeze.

When we look at complementation with nouns, we see the exact same pattern: *for-to* infinitives are unacceptable as complements to nouns that have to do with epistemic modality (34) but acceptable as complements to nouns that have to do with priority modality (35) or dynamic modality (36).

(34) EPISTEMIC

    a. *the belief **for** hydrangeas to grow here

    b. *the knowledge **for** hydrangeas to grow here

(35) PRIORITY

    a. the requirement **for** John to leave

    b. the desire **for** John to leave

    c. the goal **for** John to leave

(36) DYNAMIC

    a. the ability **for** John to leave

    b. the opportunity **for** John to leave

    c. the disposition **for** John to leave

    d. the potential **for** there to be trouble

    e. the potential **for** hydrangeas to grow here

In summary, the interim conclusion of this section is that *for-to* infinitives are acceptable in contexts of priority and dynamic modality but not epistemic modality.

5. Implementation

Following Kratzer (2006), suppose attitude predicates do not introduce quantification over worlds but rather are simply predicates of eventualities, as in (37). I assume here as well that attitude predicates introduce their own external argument, though this is not crucial in what follows: it could be that the external argument is introduced by a voice head. I also assume here — inconsequentially — that beliefs and desires have experiencers (abbreviated to EXP in the formulae) whereas claims have agents (abbreviated to AG).

(37)   a. $[[\text{believe}]] = \lambda x \lambda s.\text{belief}(s) \wedge \text{EXP}(s)=x$
       b. $[[\text{want}]] = \lambda x \lambda s.\text{want}(s) \wedge \text{EXP}(s)=x$
       c. $[[\text{claim}]] = \lambda x \lambda s.\text{claim}(s) \wedge \text{AG}(s)=x$

Still following Kratzer, suppose that the modality found in attitude reports comes from functional heads in the left periphery of the embedded clause that map "entities that determine intensional content to the set of possible worlds that are compatible with that content" (Kratzer 2013:slide 51). In a sentence like (38), for example, the left periphery of the complement clause *it's raining* contains the silent modal defined in (39). This modal combines with the proposition *it's raining* to yield the set of states such that all those worlds compatible with the content of the state are worlds where it is raining. This then combines with the matrix predicate via Restrict in the sense of Chung and Ladusaw 2004. Crucially, Restrict has as a consequence that the state variable introduced by the attitude predicate and the state variable introduced by the modal are identified. This means that the state used to build the restriction of the modal is a belief state, so that what we ultimately get is the assertion that all those worlds compatible with the relevant individual's beliefs are worlds in which it is raining, just like in a standard Hintikkan approach to attitude reports.

(38)   John believes it's raining

(39) $[[\emptyset_{say}]] = \lambda p \lambda s.\forall w' \in f_{content}(s):p(w')$ (where s is a mental state or speech event)

(40) $\lambda x \lambda s.\text{believe}(s) \wedge \text{EXP}(s)=x \wedge \forall w' \in f_{content}(s):\text{it's raining in } w'$

          believe $\lambda s.\forall w' \in f_{content}(s):\text{it's raining in } w'$

                    $\emptyset_{say}$ it's raining

A feature of this approach that will be crucial for my purposes is that the modal functional heads in the left periphery of the complement clause come in different flavors, each of which can impose

its own kind of selectional restrictions. In addition to the modal defined above in (39), Kratzer (2013) proposes that there is another one associated with the German reportative subjunctive that comes along with the presupposition that "the speaker is not committed to the truth of p", as in (41), as well as one associated with the German modal *sollen*, which "requires anchors like rumors, reports, claims; rejects mental states", as in (42).

(41)   [[German reportative subjunctive]] = $\lambda p \lambda s. \forall w' \in f_{content}(s):p(w')$
       where "the speaker is not committed to the truth of p" (Kratzer 2013:slide 60)

(42)   [[sollen]] = $\lambda p \lambda s. \forall w' \in f_{content}(s):p(w')$
       "requires anchors like rumors, reports, claims; rejects mental states" (Kratzer 2013:slide 58)
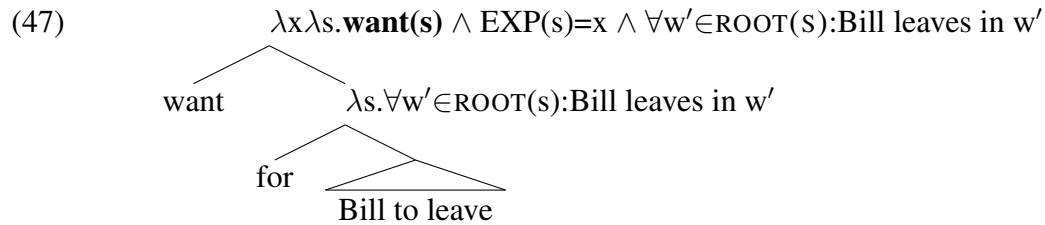
Adopting Kratzer's framework, Bogal-Allbritten (2015) proposes that the Navajo morphemes *sha'shin* and *laanaa* are overt instantiations of modals that are restricted to belief anchors and desires anchors respectively, as in (43).

(43)   a.   [[*sha'shin*]] = $\lambda p \lambda s. \forall w' \in \text{BELIEF}(s):p(w')$
       b.   [[*laanaa*]] = $\lambda p \lambda s. \forall w' \in \text{DESIRE}(s):p(w')$ (adapted from Bogal-Allbritten 2015)
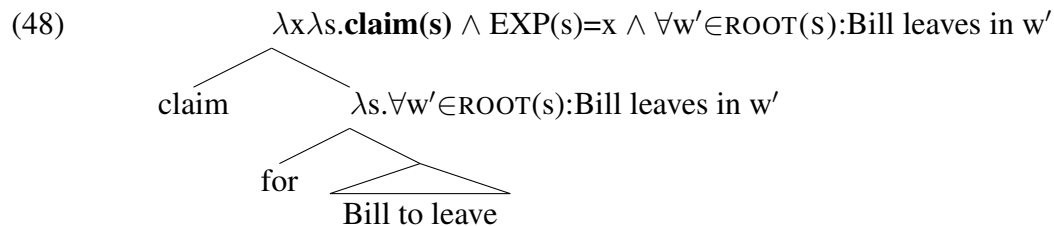
Against this backdrop, let ROOT be an accessibility function with a selectional restriction that excludes epistemic anchors but allows priority and dynamic anchors. Then I propose that the English infinitival complementizer *for* has the denotation in (44), combining with an ordinary proposition like (45) and returning the property of states in (46).

(44)   [[for]] = $\lambda p \lambda s. \forall w' \in \text{ROOT}(\text{S}):p(w')$

(45)   [[Bill to leave]] = $\lambda w.\text{Bill leaves in w}$

(46) $\lambda s. \forall w' \in \text{ROOT}(s):\text{Bill leaves in } w'$

The consequences of this setup for the complementation facts are as follows. Wanting states are appropriate anchors for ROOT, so a structure like (47) is interpretable: it will be true of an individual and a state just in case the state is a wanting experienced by the relevant individual, and all those worlds compatible with the content of the state are worlds where Bill leaves. (I ignore here the complication that desire reports involving *want* most likely need to be relativized both to a modal base and to an ordering source that involves ranking of preferences — see especially Heim 1992; von Fintel 1999; Giannakidou 1999; Villalta 2008; Anand and Hacquard 2013 — a complication which presumably could be dealt with via an appropriately articulated semantics for the ROOT function.)

(47) $\quad\quad\quad\quad\quad\quad\quad\quad\lambda x\lambda s.\textbf{want(s)} \wedge \text{EXP}(s)=x \wedge \forall w'\in\text{ROOT}(\text{S}):\text{Bill leaves in } w'$

want $\lambda s.\forall w'\in\text{ROOT}(s):\text{Bill leaves in } w'$

for

Bill to leave

Claiming states, on the other hand, because they have to do with epistemic modality, are not appropriate anchors for ROOT, so a structure like (48) is not interpretable. (48) is freely built in the syntax, but crashes in the interpretive component of the grammar because of the selectional restriction violation induced by the identification of the state variable that ROOT applies to with the state variable that **claim** applies to.

(48) $\quad\quad\quad\quad\quad\quad\quad\quad\lambda x\lambda s.\textbf{claim(s)} \wedge \text{EXP}(s)=x \wedge \forall w'\in\text{ROOT}(\text{S}):\text{Bill leaves in } w'$

claim $\lambda s.\forall w'\in\text{ROOT}(s):\text{Bill leaves in } w'$

for

Bill to leave

6. Back to aspectual verbs

The central proposal of this paper is that the ungrammaticality of *for-to* complements under *claim*, as in (49a), has the same source as the ungrammaticality of *for-to* complements under aspectual verbs, as in (49b); in particular, the infinitival complementizer *for* contributes a modal semantics that renders it incompatible with both kinds of predicates.

(49)   a. *John claimed for Bill to open the door.
       b. *John started for Bill to open the door.

Why would aspectual verbs be incompatible with the modality introduced by *for*? Possibly, the state variable introduced by aspectual verbs does not determine intensional content; i.e., aspectual verbs are not modal at all. But this option stands in tension with the observation that aspectual verbs give rise to the same kind of 'imperfective paradox' behavior that motivates modal accounts of the progressive. This is illustrated in (50).

(50)   a. John began/continued to cross the street but a bus hit him before he finished.
       b. John began/continued to draw a circle, but he stopped before there was a circle.

This leaves us with two analytical options. On the one hand, it could be that aspectual verbs describe states that determine intensional content (i.e., they are modal), but the modality differs from other kinds in a way that renders it incompatible with the ROOT accessibility function. The other option to consider is that aspectual verbs describe states that do not determine intensional content (i.e., they are not modal). These two options roughly correspond to the two families of approaches to progressive semantics, those in the modal family (Dowty, 1977, 1979; Landman, 1992; Bonomi, 1997; Portner, 1998) and those in the non-modal family (Parsons 1990; Szabó 2004, 2008; Silk 2015; cf. also Giannakidou 2013). (See also Piñango and Deo (2015) for a non-modal account of aspectual verbs.)

These two options then have repercussions for the proper analysis of the ROOT accessibility function. On the one hand, it could be that ROOT is defined negatively in being compatible with any kind of modality other than epistemic modality; such a view would entail that aspectual verbs are not modal. On the other hand, it could be that ROOT is defined positively: it is compatible with priority and dynamic modality (or whatever turns out to be the relevant category or categories); such a view would be compatible both with the position that aspectual verbs are not modal at all or with the view that aspectual verbs instantiate a kind of modality that falls outside the purview of ROOT. These two hypotheses are spelled out in (51)–(52).

(51) **Hypothesis A:** ROOT is defined negatively (any kind of modality other than epistemic); aspectual verbs are not modal.

(52) **Hypothesis B:** ROOT(S) is defined positively; aspectual verbs are either not modal or fall into some category of modal outside ROOT(S).

7. Scaling up

7.1. Other complementation options

On the analysis sketched above, the unacceptability of sentences like (53) has nothing to do with the presence of the overt embedded subject *per se*; rather, the problem has to do with the semantics of *for*.

(53) *John began for Bill to open the door.

A natural question to ask, then, is what happens when we try alternative strategies for licensing an overt embedded subject under *begin*. As seen in the data in (54)–(56), other potential strategies fail as well: *begin* rejects finite complements (55), ECM complements (55), and overt-subject gerundive complements (56).

(54) *John began that Bill opened the door.   FINITE COMPLEMENTATION

(55) *John began Bill to open the door.   ECM

(56) *John began Bill opening the door.   GERUNDIVE COMPLEMENT

I would like to suggest that the rejection of finite complements and ECM complements can both be understood along the same lines as the rejection of *for-to* complements. In particular, following Kratzer (2013) as reviewed above, the covert modal in a finite complement requires an anchor that denotes a mental state or a speech event. Regardless of what kind of state variable an aspectual verb contributes, it is uncontroversially neither a mental state nor a speech event. Consequently, sentences like (54) are uninterpretable. Similarly, Moulton (2009) has argued that ECM clauses always contribute epistemic modality. This proposal is based in part on the observation that perception verbs admit ECM complements, but do so in a way that reports a belief on the part of the perceiver (57), unlike what happens when a perception verb takes a gerundive complement (58)

(57)   Martha saw Fred to be driving too fast, #but she believed he wasn't.

(58)   Martha saw Fred driving too fast, but she believed he wasn't. (Moulton 2009:128–129)

Consequently, my suggestion is that whereas the state variable introduced by *see* can be construed in a way that builds epistemic alternatives, the state variable introduced by an aspectual verb cannot, and we thereby predict uninterpretability for sentences like (55).

Finally, the unacceptability of (56) is more puzzling: *begin* freely accepts controlled gerundive complements, as in *John began opening the door*. Why can we not understand (56) to mean that John was the agent of an event that constituted the onset of an event of Bill opening the door? Although I do not have an explanation for this, it bears noting that if we manipulate the choice of the aspectual verb and the embedded predicate, it is sometimes possible to get a grammatical result, as in (59).

(59)   a. John started Bill smoking.
       b. John kept the candle burning.

I leave the contrast between (56) and (59) as an open puzzle. But I also take the data in (59) as support for the overall proposal that there is in principle no barrier to having an overt embedded subject under an aspectual verb.

7.2. Other languages

As stated in section 2 above, aspectual verbs disallow different-subject complements not just in English but across typologically diverse languages such as Mandarin and Greek. Consequently, my suggestion is that in these languages as well, overt-subject licensing is bound up with a modality-introducing functional head, albeit not always overt. This suggestion has interesting consequences especially for languages like Greek that lack nonfinite complementation. Given the contrast between (60a) and (60b), not all Greek *na*-clauses are created equal: *na*-clauses with overt subjects have the characteristic *for-to* semantics that render them incompatible with aspectual verbs, whereas *na*-clauses with controlled subjects have a wider distribution akin to English controlled infinitives.

(60)   a.   O   Yanis arxise na   anoigi tin porta.
           the Yanis began SBJV opens the door
           'Yanis began to open the door.'

        b.   *O Yanis arxise na   anoigi tin porta **i   Maria**.
           the Yanis began SBJV opens the door the Maria
           '*Yanis began for Maria to open the door.'   GREEK

8. Conclusions

In this paper, I have argued that aspectual verbs are bona fide control verbs: they can occur with an external argument, and this makes their incompatibility with different-subject complements puzzling. I furthermore argued that a promising solution to their incompatibility with *for-to* complements in particular relies on a decompositional approach to embedding coupled with a restrictive modal semantics for infinitival complementizer *for*. The consequence of such an approach is that there is no problem with different-subject complements *per se*; rather, there is a syntax-semantics "conspiracy" wherein overt-subject licensing necessitates functional material whose meaning conflicts with the aspectual verbs. To the extent that all the semantic pieces are independently motivated, this has a welcome, simplifying consequence for the syntax: we can let the syntax generate sentences like *John began for Bill to open the door*; the semantic component alone accounts for its deviance.

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German *erst* — a temporal addition to the 'exclusive muddle'[1]

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Abstract. In 'Principles of the Exclusive Muddle', Coppock and Beaver (2014) suggest a scalar common core meaning for a plethora of exclusive particles in English, suggesting that the particles differ in (i) their semantic type, (ii) the kind of scale the focus alternatives are ranked on, and (iii) the constraints placed on the QUD. This paper contributes to this discussion by proposing an analysis of the temporal exclusive *erst* ('not until') in German, based on the same core meaning.

Keywords: focus-sensitivity, exclusive particles, aspectual particles, *not until*.

1. The 'exclusive muddle'

This section presents an introduction to exclusive particles and the unified account presented in Coppock and Beaver (2014), Beaver and Clark (2008) for their meaning contribution.

1.1. An introduction to exclusive particles

Under an alternative semantic view of focus, focus induces alternatives (e.g. Rooth 1985, 1992, 1996). For example, the focus alternatives of (1), with focus on *Ben*, is the set of propositions of the form *Ali saw X*, for different X. The proposition expressed by (1) is itself part of the alternatives.

(1)   Ali saw **Ben**$_F$.
        Alternatives: e.g. *Ali saw Ben, Ali saw Cem, Ali saw Ben and Cem, ...*

These alternatives are modelled as alternative answers to a (often implicit) *question under discussion* (QUD), e.g. *Who did Ali see?* in (1) (e.g. Roberts 1998, 2012, Büring 1997). Under the assumption that the denotation of a question is the set of its possible answers (cf. Hamblin 1973), the sentence in (1) indicates a QUD corresponding to its focus alternatives. Below, following Beaver and Clark (2008), the current QUD will sometimes be abbreviated as CQ.

Exclusive particles like English *only* interact with the focus alternatives of their *prejacent*, i.e. of the sentence without the exclusive. They contribute a truth-conditional meaning component, an assertion that all alternatives not entailed by the prejacent are false. For example, (2) asserts that any stronger focus alternatives of the prejacent, i.e. stronger alternatives of the form *Ali saw X* are false. In contrast, (3) asserts that stronger alternatives of the form *Ali X-ed Ben* are false. Example

(3), in contrast to (2), is thus compatible with a context in which Ali also saw Cem, but not with a context in which Ali did something additional to Ben.

(2)   Ali *only* saw **Ben**$_F$.
        Alternatives: e.g. *Ali saw Ben, Ali saw Cem, Ali saw Ben and Cem, ...*

(3)   Ali *only* **saw**$_F$ Ben
        (Alternatives e.g. *Ali saw Ben, Ali saw and greeted Ben, ...)*

Most accounts of *only* propose that **all** focus alternatives other than the prejacent are asserted to be false. This however depends on the kinds of alternatives that are assumed. If a plural focus like (4) can have singular alternatives like *Ali saw Ben*, which is true in (4), then it is preferable to assume that only those alternatives which are not entailed by the prejacent are asserted to be false.

(4)   Ali *only* saw **Ben and Cem**$_F$.
        Alternatives: e.g. *Ali saw Ben, Ali saw Cem, Ali saw Ben and Cem, ...*

This assertion that the prejacent is the strongest true alternative, is called the MAX-component in Coppock and Beaver (2014). In addition, following Beaver and Clark (2008), they assume a presuppositional MIN-component: a presupposition that some alternative which is at least as strong as the prejacent is true. This MIN/MAX account is presented in the following section.

1.2. A MIN/MAX approach to exclusive particles

Coppock and Beaver (2014) propose that all exclusive particles in English, e.g. *only, just, merely*, etc. have a common core. First, they are all *scalar*: they require that the focus alternatives with which they interact are ranked on a salient scale of strength. Second, exclusive particles trigger the presupposition that there is a true focus alternative which is at least as strong as the prejacent, i.e. that some alternative ranked as high or higher on the scale as the prejacent is true (= the MIN-component). Third, exclusive particles contribute a truth-conditional meaning component that stronger alternatives, i.e. alternatives ranked higher on the scale, are false (= the MAX-component). As a propositional operator, *only* would have the meaning in (5) (Coppock and Beaver 2014: 24, adapted from Beaver and Clark 2008), with the MIN and MAX-components in (6).

(5) $[\![only]\!]^S$ (6) $\text{MIN}_S(p) = \lambda w. \exists p' \in CQ_S[p'(w) \land p' \geq_S p]$
        $= \lambda p. \lambda w : \text{MIN}_S(p)(w). \text{MAX}_S(p)(w)$ $\text{MAX}_S(p) = \lambda w. \forall p' \in CQ_S[p'(w) \rightarrow p \geq_S p']$

This section shows some examples and then discusses the differences between different exclusives.

For example, for (7), the focus alternatives are ranked on a scale of strength like (8). In this example, the scale is an entailment scale: alternatives ranked higher on the scale entail those alternatives which are ranked lower on the scale. Since *only* triggers the presupposition that an alternative which is ranked at least as high as the prejacent is true, lower-ranked alternatives, e.g. *One student left* in (7)–(8), are not considered as possible answers to the QUD[2]. This amounts to the presupposition in (7-a) for this example, that at least two students left. The sentence (7) then asserts that all alternatives stronger than the prejacent are false, paraphrased as (7-b). The prejacent is thus the strongest true answer to the QUD.

(7) (QUD: How many students left?)
     Only **two**_F students left

     a. P: At least two students left. (MIN)
     b. A: At most two students left. (MAX)

(8)
···
~~Three students left~~
Two students left
One student left
···

For examples like (9), a scale like (10) is assumed, which is also an entailment scale (albeit partially ordered instead of totally ordered). The presupposition that there is a true alternative at least as strong as the prejacent leads to the consideration of only those alternatives which entail the prejacent. All stronger alternatives than the prejacent are asserted to be false.

(9) (QUD: Who left?)
     Only **Ali**_F left

     a. P: At least Ali left. (MIN)
     b. A: At most Ali left. (MAX)

(10)
~~Ali, Ben & Cem left~~
~~Ali & Ben left~~   ~~Ali & Cem left~~   Ben & Cem left
Ali left   Ben left   Cem left

As already shown in Beaver and Clark (2008), this analysis can also account for evaluative readings of *only*, e.g. (11). In these cases, the scale involved is a rank-order scale such as (12), in which higher-ranked alternatives do not entail lower-ranked alternatives (Coppock and Beaver 2014). The ranking here is evaluative, evaluating e.g. the importance of the job. Again, the presupposition excludes all lower-ranking alternatives as candidates for the strongest true answer, and the assertion excludes all higher-ranking alternatives.

(11) (QUD: What is Cem's occupation?)
      Cem is *only* **a PhD student**_F.

      a. P: Cem is at least a PhD student. (MIN)
      b. A: Cem is at most a PhD student. (MAX)

(12)
···
~~Cem is a postdoc~~
Cem is a PhD student
Cem is a master student
···

---

[2]In the example scales, unconsidered lower-ranking alternatives are printed in a light gray. The alternatives which are excluded due to the assertion are struck out. The remaining alternatives are printed in bold font.

Beaver and Clark (2008) show that the different kinds of scales (entailment vs. rank-order) can account for the fact that the prejacent survives negation in entailment scale examples, but not in rank-order examples. Compare (13-c) to (13-a–b): under the evaluative reading, the prejacent *Cem is a PhD student* does not survive. (13-c) could e.g. be continued with ... *he is a postdoc*.

(13) a. It's not the case that *only* **two** students left   → Two students left
      b. It's not the case that *only* **Ali** left   → Ali left
      c. It's not the case that Cem is *only* **a PhD student**   ↛ Cem is a PhD student

This difference follows from the different scales: The negative assertions in (13-a–c) lead to the exclusion of the prejacent as the strongest true answer[3]. All remaining candidates for the strongest true answer are alternatives which are stronger than the prejacent. On entailment scales like (i) and (ii), these stronger alternatives entail the prejacent. Since one of them is presupposed to be true, and all of them entail the prejacent, the prejacent is entailed in (13-a-b). In (13-c), with the scale in (iii), the remaining alternatives do not entail the prejacent.
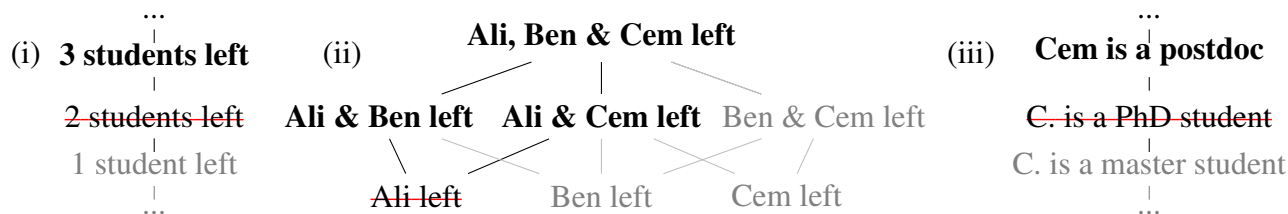
Coppock and Beaver (2014) note that different exclusive particles can differ in several ways: First, they differ with respect to the kinds of scales they allow (*strength ranking*). Second, they can appear in different syntactic positions and thus differ with respect to the type of their complement (*type*). Third, they impose restrictions on the kinds of QUDs that are possible (*question*). Instead of a propositional *only* shown above, Coppock and Beaver (2014: 56) therefore propose different lexical entries for different exclusives, following the lexical entry schema for exclusives in (14).

(14) $\lambda\alpha.\lambda\beta_1.\,...\,.\lambda\beta_n.\lambda w$:
      $\text{CQ}_S \subseteq \Omega \wedge$ // question parameter
      $\Gamma(\leq_S) \wedge$ // strength ranking parameter
      $\text{MIN}_S(\alpha(\beta_1)...(\beta_n))(w).\text{MAX}_S(\alpha(\beta_1)...(\beta_n))(w)$ // min-component, max-component

---

[3]When the MAX-component is negated, it entails that there is a true alternative in the CQ which is stronger than the prejacent. This is due to the following equivalences:

(i) $\neg\forall x{\in}A, P(x) \Leftrightarrow \exists x{\in}A, \neg P(x)$, therefore: $\neg[\forall p' \in \text{CQ}_S\ p'(w) \rightarrow p'{\geq_S}p] \Leftrightarrow \exists p' \in \text{CQ}_S\ \neg[p'(w) \rightarrow p'{\geq_S}p]$

(ii) $\neg[p \rightarrow q] \Leftrightarrow p \wedge \neg q$, therefore: $\exists p' \in \text{CQ}_S\ \neg[p'(w) \rightarrow p' \geq_S p] \Leftrightarrow \exists p' \in \text{CQ}_S\ [p'(w) \wedge \neg[p' \geq_S p]]$

For example, *sole* imposes restrictions on the QUD and scale, according to Coppock and Beaver (2014). It is adjectival and requires that the alternatives it associates with are ranked on an entailment scale. It also requires a specialized question: it takes a property P as an argument and requires the alternatives to be possible answers to the question *Who Ps?*, see (15)–(16).

(15)   (QUD: What all is a purpose of this?)   (16)
        The *sole* purpose of this is **fun**.

~~...is fun, fame & money~~

~~...is fun & fame~~   ~~...is fun & money~~ ...is money & fame

...is fun   ...is fame   ...is money

The main proposal of this paper is that the MIN/MAX account can be extended to the German (temporal) exclusive particle *erst*. This particle contributes the same presupposed MIN component and asserted MAX component as the other exclusive particles discussed in this section. Like many other exclusive particles, it however poses certain requirements on the QUD and the scale. The following section provides an introduction to *erst* and presents and discusses the analysis.

2. German *erst*

In this section, the meaning contribution of *erst* is discussed: first informally in section 2.1, then in a MIN/MAX account of *erst* is presented in sections 2.2 and 2.3. The latter section explains, step by step, how the inferences discussed in 2.1 are explained under this analysis.

2.1. An introduction to *erst*

"*Erst*" in (17) is a temporal exclusive, similar to "not until" in English (cf. e.g. Karttunen 1974, Condoravdi 2008, Declerck 1995). This section briefly discusses the status of some inferences of (17): (i) an inference that the event in question didn't happen earlier (*exclusive*, (18-a)), (ii) an inference that the event took place at the mentioned time (the *prejacent*, (18-b)), (iii) an inference that the event took place (which Condoravdi (2008: 635) calls *actualization*) (18-c), (iv) a *lateness* inference, expressing that the event happened unexpectedly late (18-d).

(17)   Jan ist *erst* **um 9** abgereist.
        Jan is PRT at   9 left
        "Jan didn't leave until 9."

(18) a.   Jan didn't leave earlier   (exclusive)
       b.   Jan left at nine   (prejacent)
       c.   Jan left   (actualization)
       d.   9 O'clock is late for Jan to leave   (lateness)

When (17) is embedded under a non-veridical operator, such as in (19), the inferences in (18-c–d) survive (they 'project'), whereas (18-a–b) do not survive ('do not project').

(19)   Ich wünschte, Jan wäre *erst* **um 9** abgereist.
       I   wish   Jan had   PRT at   9 left
       "I wish Jan hadn't left until 9."

The prejacent in (18-b) can be suspended, cf. (20) (e.g. Horn 1972). Suspension of an inference is similar to cancellation: a sentence negating the inference is appended to the sentence that gives rise to the inference. In contrast to cancellation, the second clause is weakened using a modal or conditional. For example, the first clause in (20) gives rise to the inference that Jan left at 9. The next clause is a modalized denial of this inference, stating that maybe he didn't leave before ten.

(20)   Jan ist *erst* **um 9** abgereist, vielleicht sogar erst um 10.
         Jan is PRT at   9 left   perhaps   even PRT at   10.
         "Jan didn't leave until 9, perhaps even not until 10."

On first glance, the actualization and lateness inferences seem to be presuppositions, since they project, whereas the exclusive component seems to be asserted (being non-projective, and, as will be shown in §2.3, non-suspendable). The prejacent inference is also non-projective, but suspendable. After proposing an analysis in 2.2, section 2.3 discusses how to account for these inferences.

2.2. A MIN/MAX analysis of *erst*

Erst can be added to Coppock and Beaver (2014)'s typology of exclusives. Recall that they propose that all exclusives are scalar, with a presupposed MIN component and an asserted MAX component, but that exclusives can differ with respect to the parameters *question, strength ranking*, and *type*.

Concerning the *question*-parameter, *erst*-sentences answer a specialized QUD asking for the endpoint of the considered interval in which the event took place, e.g. "*By when (= between t_{start} and when) did Jan leave?*". I adopt, from De Swart (1996)'s analysis of *until*, the assumption that there is an implicit startpoint t_{start} of the interval under consideration and assume that all alternatives share this startpoint. Since the QUD asks for the endpoint of the interval within which the event took place, rather than asking for the actualization time of the event itself, the alternatives will be paraphrased as *between*-phrases (e.g. *Jan left between t_{start} and 9*).

The resulting scale is an entailment scale, i.e. the *strength ranking* is entailment, cf. (21). The fact that alternatives involving shorter intervals entail those involving longer intervals is due to the punctuality of the predicate (Grubic 2012): if the predicate were durative, e.g. *stay*, the direction of entailment would be reversed, e.g. *Jan stayed between t_{start} and 9* would entail *Jan stayed between t_{start} and 8*, but not vice-versa. I assume this to be responsible for the unacceptability of *erst um 9*

and its counterparts in other languages with durative predicates, e.g. (22)[4,5].

(21)   …
          ~~J. left between t_{start} and 8~~
          J. left between t_{start} and 9
          J. left between t_{start} and 10
                    …

(22)   #Jan blieb   *erst* **um 9**.
        Jan stayed PRT at   9
        "Jan only stayed at 9"

Concerning the semantic *type*, *erst* in (17) forms a constituent with the temporal adverbial *um 9*, as can e.g. be seen by the fact that the whole *erst*-phrase can be preposed (23). I assume, following e.g. von Stechow (2009), that the temporal adverbial *um 9* ("at nine") is a property of times (here: type $\langle i, st \rangle$). It can combine with the predicate directly via predicate modification (24).

(23)   [*Erst* **um 9**] ist Jan abgereist.
        "Jan didn't leave until 9"

(24)   Jan ist um 9 abgereist.
        "Jan left at 9 O'clock"

The strongest true answer on the scale in (21) does not correspond to (24), however. Nine is merely the endpoint of the considered interval; its starting point is at an earlier, contextually provided starting point t_{start}. Intuitively, the presupposition and assertion of (17) should be the following:

(25)   Jan ist *erst* **um 9** abgereist   ("Jan didn't leave until 9.")
        P: there is a true answer at least as strong as 'Jan left between t_{start} and 9'
        A: the strongest true answer is at most as strong as 'J. left between t_{start} and 9'

I propose that *erst* requires a temporal adverbial which already provides this extended interval as an argument, cf. (26), where INT[t,t'] is the interval from the beginning of t to the end of t'[6].

(26)   a.   [[um 9 Uhr]] = $\lambda t.[t = 9$ O'clock]
        b.   [[OP]] = $\lambda R_{\langle i,st \rangle}.\lambda S_{\langle i,st \rangle}.\lambda t.\lambda w.$ S(t $\cap$ INT[t_{start}, END(R)])(w)
        c.   [[OP um 9 Uhr]] = $\lambda S_{\langle i,st \rangle}.\lambda t.\lambda w.$ S(t $\cap$ INT[t_{start}, END($\lambda t.$ t = 9 O'clock)])(w)
              $\approx \lambda S_{\langle i,st \rangle}.\lambda t.\lambda w.$ S(t $\cap$ INT[t_{start}, 9 O'clock])(w)

---

[4]If sentences with such predicates are interpretable at all, they get an inchoative, and thus punctual, reading, e.g. *run* in (i) is interpreted as *begin to run* (cf. also Giannakidou 2002: 5, Karttunen 1974: 289).

(i)   [?]Jan rannte *erst* **um 9**   ("Jan didn't run until 9")

[5]Note however that the PP *um 9* must also be partly responsible for this requirement, since #*Jan blieb um 9* is also odd. A more thorough discussion of *erst* would have to include a discussion of other PPs which can occur with *erst*, as well as their interaction with aspect and Aktionsart, e.g. *seit* ('since'), *nach/nachdem* ('after'), *als/wenn* ('when'), etc.

[6]The operator END returns the latest time point which has the property R: END(R) = ιt[R(t) & $\forall t'$[R(t') $\rightarrow$ t' $\prec$ t], the formula is simplified in the following, so that INT[t, 9 O'clock] is an interval lasting up to the 'end' of O'clock.

Following the schema in (14), (27) is the lexical entry proposed for *erst*[7]: it is a modifier, modifying a temporal adverbial of type $\langle\langle i, st\rangle, \langle i, st\rangle\rangle$.

(27) $[[\text{erst}]]^S = \lambda P_{\langle\langle i,st\rangle,\langle i,st\rangle\rangle}.\lambda Q_{\langle i,st\rangle}.\lambda t.\lambda w:$

         $CQ_s \subseteq ?t'[\lambda w.[Q (t \cap \text{INT}[t_{start}, t'])(w)]]$ // By when did Q happen?

         $\wedge \text{ENTAILMENT}(\geq_S)$ // Strength: entailment

         $\wedge \text{MIN}_S(P(Q)(t))(w). \text{MAX}_S(P(Q)(t))(w)$ // at least by P, at most by P

The following is the derivation of (17) using (26) and (27) (ignoring the presuppositions in (28-a)).

(28)   a. $[[\text{erst OP um 9 Uhr}]] = \lambda Q_{\langle i,st\rangle}.\lambda t.\lambda w.\text{MAX}_S(Q(t \cap \text{INT}[t_{start}, 9 \text{ O'clock}]))(w)$

      b. $[[\text{erst OP um 9 Uhr}]] ([[\text{Jan ist abgereist}]])(t)$

          $= \lambda w.\text{MAX}_S(\lambda w. \text{Jan left at } t \cap \text{INT}[t_{start}, 9 \text{ O'clock}] \text{ in } w)(w)$, defined iff

         (i) $CQ_s \subseteq ?t'[\lambda w.\text{Jan left at } t \cap \text{INT}[t_{start}, t'] \text{ in } w]$

         (ii) $\text{ENTAILMENT}(\geq_S)$

         (iii) $\lambda w.\text{MIN}_S(\lambda w.\text{Jan left at } t \cap \text{INT}[t_{start}, 9 \text{ O'clock}] \text{ in } w)(w)$

Erst is thus an exclusive which places restrictions on the QUD ("*Between t_{start} and when...?*"), the scale (entailment), and the type of its complement (e.g. $\langle\langle i, st\rangle, \langle i, st\rangle\rangle$). Given these prerequisites, *erst* in (17) behaves exactly like the other exclusives described in Coppock and Beaver (2014): (i) it is *scalar*, with alternatives differing in the endpoint of the considered interval ordered on an entailment scale, (ii) it presupposes a MIN component, and (iii) asserts a MAX component.

2.3. Accounting for the data

This analysis explains the behaviour of the exclusive, actualization, lateness and prejacent inferences discussed in section 2.1 above and shown again in (30) (for example (29)).

(29)   Jan ist *erst* **um 9** abgereist.
        Jan is PRT at   9 left
        "Jan didn't leave until 9."

(30)   a.   Jan didn't leave earlier   (exclusive)

      b.   Jan left at nine   (prejacent)

      c.   Jan left   (actualization)

      d.   9 O'clock is late for Jan to leave   (lateness)

First, the fact that earlier alternatives are excluded (= the *exclusive* inference) is due to the asserted

---

[7]All permissible lexical entries for exclusives are formed from the propositional version using the Geach rule, which Coppock and Beaver (2014: 27) describe as follows: "The Geach rule converts a function f with type $\langle a, b\rangle$ into a function f' with type $\langle\langle c, a\rangle, \langle c, b\rangle\rangle$ of the form $\lambda R.\lambda x.f(R(x))$, where R has type $\langle c, a\rangle$ and x has type c." This rule is the main reason for treating the adverbial as type $\langle\langle i, st\rangle, \langle i, st\rangle\rangle$ instead of $\langle\langle i, t\rangle, \langle i, t\rangle\rangle$.

MAX-component, which excludes stronger alternatives. In the case of *erst*, all stronger alternatives involve temporal intervals with an earlier endpoint. That weaker alternatives, i.e. alternatives with a later endpoint, are not considered is due to the presupposed MIN-component. This is exactly the same as with *only*, where weaker alternatives are also not considered, and stronger alternatives are asserted to be false, compare (31)–(32).

(31)
$$\vdots$$
~~J. left between t_{start} and 8~~
J. left between t_{start} and 9
J. left between t_{start} and 10
$$\vdots$$

(32)
$$\vdots$$
~~Three students left~~
Two students left
One student left
$$\vdots$$

That the *actualization* inference, e.g. the inference of (29) that *Jan left*, survives negation is due to the fact that all considered alternatives entail that Jan left. Since it is presupposed that there is a true alternative at least as strong as *Jan left between t_{start} and 9*, one of these alternatives has to be true. Therefore, it has to be true that Jan left.

Beaver and Clark (2008: 251) suggest in their informal description of the meaning contribution of *only* that its discourse function is to indicate counter-expectation, cf. (33). They call this the *mirative* meaning component. It is a projective meaning component expressing that the answer is unexpectedly weak, i.e. that a stronger answer was expected to be true. For example, *Only two students left* expresses that more students were expected to leave (cf. also Zeevat 2009).

(33)   Discourse function [of exclusives]: To make a comment on the [current QUD (CQ)], a comment which weakens a salient or natural expectation. To achieve this function, the prejacent must be weaker than the expected answer to the CQ on a salient scale.

This meaning component is not represented in their formal description of *only* (Beaver and Clark 2008: 261), nor in Coppock & Beaver's variant (Coppock and Beaver 2014: 24), except possibly via the fact that the prejacent, being the weakest considered answer, is at the borderline of the considered answers. In Grubic (2015: §7.4.2), I propose that there is independent evidence that speakers keep track of hearer-expectations concerning the relative probability of the different answers to the current QUD, and that it would be beneficial to represent the mirative component separately from the MIN-component. Whatever the right analysis for the mirative meaning component of *only* sentences is, the *lateness* meaning component of *erst* sentences should receive the same analysis, cf. (34). This is a projective meaning component expressing that the actualization time of the event was unexpectedly late. Since 'earlier' alternatives are stronger, this amounts to an expectation that a stronger alternative is true, just as in the case of *only* in (35).

(34) Jan ist *erst* um **neun**$_F$ abgereist.   (35)   *Only* **two**$_F$ students left.
      "Jan didn't leave until nine."   → More students were expected to leave
      → Jan was expected to leave earlier.

The suspendability of the prejacent, e.g. *Jan left at 9*, is due to the interaction of the MIN and MAX component. The suspension example was (20), repeated here as (36). Recall that, in the account here, 'later' alternatives are weaker and are thus excluded via the MIN-presupposition. In (36), these previously discarded weaker alternatives are reconsidered. This reconsideration is also possible with *only*, cf. (37), as discussed in Beaver and Clark (2008: §9.6–§9.10).

(36)   Jan ist *erst* **um 9** abgereist, vielleicht sogar erst um 10.
       Jan is PRT at 9 left   perhaps even PRT at 10.
       "Jan didn't leave until 9, perhaps even not until 10."

(37)   *Only* **two**$_F$ students left, perhaps even only one$_F$ (student left).

Condoravdi (2008: 647f) suggests for similar English examples that the fact that this is felicitous suggests that the prejacent is a conversational implicature. Note, however, that cancellation is not possible in these cases (cf. Beaver and Clark 2008: 228 for the same observation for English *only*).

(38)   Jan ist *erst* **um 9** abgereist, #ja sogar erst um 10.
       Jan is PRT at 9 left   yes even PRT at 10.
       "Jan didn't leave until 9, in fact, even not until 10."

(39)   *Only* **two**$_F$ students left, #in fact, only one$_F$ student left.

The prejacent is not an implicature. It is entailed by the MIN-presupposition, rejecting later alternatives, together with the MAX-assertion, rejecting earlier alternatives. The suspension in (36) is in fact a suspension of the MIN component, a reconsideration of the QUD, taking weaker, previously unconsidered alternatives into account[8]. The MAX-assertion is not suspendable, cf. (40)–(41).

(40)   #Jan ist *erst* **um 9** abgereist, vielleicht sogar (schon) um 8.
       Jan is PRT at 9 left   perhaps even already at 8.
       "Jan didn't leave until 9, perhaps even (already) at 8."

(41)   *Only* **two**$_F$ students left, # perhaps even three$_F$ (students left).

---

[8]Coppock and Beaver (2014: 18), citing Horn (1970, 2011), note that presuppositions can be suspended if this makes the claim more universal.

To sum up, this section showed parallels between inferences discussed in the literature for *erst* and those discussed for *only*. First, both have an exclusive meaning component, which, I argue, also excludes *stronger* alternatives in the case of *erst*. Second, the explanation for why the *actualization* inference in *erst* sentences survives embedding under negation is the same as the explanation for prejacent projection in entailment scale *only* sentences: all considered alternatives entail it. Third, both *only* and *erst* have a meaning component indicating that the true alternative is 'surprisingly weak' (the *mirative* and *lateness* component, respectively). And fourth, in both cases, the prejacent can be suspended, which was explained as a reconsideration of the QUD.

3. Discussion

In this section, the MIN/MAX-account proposed here is compared to earlier analyses of *erst* and *not...until* and some further *erst* data is discussed.

3.1. Comparison to earlier analyses

The current account is very similar to the proposals of Karttunen (1974) and Condoravdi (2008) for *not...until* in English, cf. (42)–(43)[9], where A is the event, T is the time indicated by the *until*-phrase, and I is an interval containing T.

(42)   Karttunen's *not...until*:   (43)   Condoravdi's *not...until*:

     P: (A AT T) ∨ (A BEFORE T)   P: A at some point in I
     A: NOT(A BEFORE T)   A: NOT(A BEFORE T)
          → A AT T   Implicature: NOT(A AFTER T)

Both assume that *until* is lexically ambiguous between a durative and a punctual *until*, cf. (44), refuting earlier analyses stating that this ambiguity is due to scope (e.g. Mittwoch 1977). The reading obtained with punctual *until* (44-a), which is an NPI, corresponds to the *erst* reading discussed above[10]. The two kinds of *until* differ with respect to the kinds of predicates they can occur with (punctual or durative). They also differ, as (44) shows, with respect to the status of the inference that a change occured at the time mentioned: while (44-b) merely conversationally implicates that Jan left at 9, this inference is stronger in (44-a) (Karttunen 1974: 290).

(44)   a.   Jan didn't leave **until** 9 (# in fact, he didn't leave until 10).   (*punctual until*)
          b.   Jan stayed **until** 9 (in fact, he stayed until 10)   (*durative until*)

---

[9] Karttunen (1974: 286) attributes the idea that punctual *until* has the same truth conditions as *before* to Lindholm (1969).

[10] Other languages with different lexical items for durative and punctual *until* include Finnish (Karttunen 1974), Greek, Icelandic, Czech, and Dutch (according to Giannakidou 2002), cf. Giannakidou (2002, 2003), Condoravdi (2008) for a discussion of the Greek counterparts.

The current proposal is very similar to Karttunen's proposal in that it presupposes that the event took place at T or before T and asserts that it didn't take place before T. However, Karttunen does not discuss *not...until* as focus-sensitive and scalar. Condoravdi amends this, proposing an account in which the alternatives are ordered on a scale, with the 'latest' alternative being the strongest, cf. (45) (differing from the scale assumed here, cf.(46)). The assertion ('NOT(A BEFORE T)'), excludes weaker, 'earlier' alternatives, while the exclusion of stronger alternatives is an implicature.

(45)
···
J. didn't leave between t_{start} and 10
J. didn't leave between t_{start} and 9
~~J. didn't leave between t_{start} and 8~~
···

(46)
···
~~J. left between t_{start} and 8~~
J. left between t_{start} and 9
J. left between t_{start} and 10
···

Condoravdi presents this proposal because she analyses the suspension data shown above as an indication that the exclusion of later alternatives is a conversational implicature. As discussed above, this is rejected here, because it cannot be cancelled. Instead, the current account returns to Karttunen's analysis of this exclusion as a presupposition: it is the MIN component of Beaver and Clark (2008), Coppock and Beaver (2014). The current proposal is thus similar to Condoravdi's proposal for *not...until* in acknowledging the focus-sensitivity and scalarity of *erst*. It differs in the scale assumed, i.e. essentially in the role negation plays for the scale.

Karttunen and Condoravdi both also present a proposal for *erst*: Karttunen (1974: 294) suggests that it has the same presupposition as *not...until*, but asserts its prejacent, cf. (47). This proposal however cannot account for the suspendability of the prejacent. Condoravdi (2008: 647) also proposes that *erst* has the same presupposition as *not...until*, but a different assertion, cf. (48), with the scale in (49), which unfortunately predicts the same implicature as her *not...until* account.

(47)   Karttunen's *erst*:
         P: (A AT T) ∨ (A BEFORE T)
         A: A AT T
              → NOT(A BEFORE T)

(48)   Condoravdi's *erst*:
         P: A at some point in I
         A: A AT T ∨ A AFTER T
              Implicature: NOT(A AFTER T)

(49)
···
J. left between 10 and t_{end}
J. left between 9 and t_{end}
~~J. left between 8 and t_{end}~~
···

The current account has the advantage that it provides a unified analysis of exclusive *only* and *erst*, as e.g. advocated by Declerck (1995), while retaining Beaver and Clark (2008)'s elegant analysis of exclusives. The following section presents some further similarities between *erst* and *only*.

3.2. Further similarities between *erst* and *only*

Obligatory association with focus   Beaver and Clark (2008) propose a typology of focus-sensitive operators, in which operators differ in whether they semantically associate with focus, or pragmatically, i.e. essentially, whether they are always required to associate with focus. One test for this is association with weak, unfocusable pronouns (Beaver and Clark 2008: 149ff.): *Always*, although it is focus-sensitive, can associate with such particles (e.g. *it* in (50-b)), but *only* cannot (50-a).

(50)   a.   *People who grow rice *only* eat **it**.
           b.   People who grow rice *always* eat **it**.

Erst seems to pattern like *only* and German *nur* (= 'only') in this respect: it can associate with a strong, stressable pronoun *das*, but not with the unstressable pronoun *es*, cf. (51) (cf. also Krifka (1998) for the use of the same test with additive particles in German)[11].

(51)   You were watching a really sad movie and were trying not to cry in front of your friends. What was your reaction to the death of the main character?

           a.   Das/**Es** hat mich zum Weinen gebracht.
                "That/it made me cry"

           b.   *Erst* das/***es** hat mich zum Weinen gebracht.
                "I didn't cry until that/*it"

           c.   *Nur* das/***es** hat mich zum Weinen gebracht.
                "Only that/*it made me cry."

---

[11]It is not entirely clear whether *erst* and *nur* (= "only") can associate with extracted constituents in German, which is a further test for the requirement to associate with focus. While the (a) sentence in (i) is odd, just as Beaver and Clark (2008: 175) predict, (b) is much better. The same holds for the *erst* sentences in (ii).

(i)   a.   ***Blumen** denke ich dass Jan *nur*   mitgebracht hat
               flowers think I   that Jan only brought   has

          b.   [?]**Blumen** denke ich hat Jan *nur*   mitgebracht
               flowers   think I   has Jan only brought
               "I think Jan has only brought FLOWERS."

(ii)   a.   ***Um 8 Uhr**   denke ich dass Jan *erst*   die Hausaufgaben macht.
               at   8 O'clock think I   that Jan ERST the homework   does

         b.   [?]**Um 8 Uhr**   denke ich macht Jan *erst*   die Hausaufgaben.
               at   8 O'clock think I   does Jan ERST the homework
               "I think Jan won't do the homework until 8 O'CLOCK."

Co-occurrence with *at most* and *at the earliest*   Another parallelity between *only* and *erst* is the possibility of co-occurring with *at most* and *at the earliest*, but not with *at least* and *at the latest*[12].

(52)   a.   *Only at most/#least* **two**$_F$ students left.
        b.   Jan ist *erst frühestens/#spätestens* **um neun**$_F$ abgereist.
             'Jan didn't leave until 9 at the earliest / #at the latest'

Stronger alternatives involve a higher number of students in (52-a) and 'earlier' alternatives (52-b). Since the function of these statements is to exclude stronger alternatives, it is thus intuitively clear why *at least* and *at the latest*, which would include these stronger alternatives, are infelicitous[13].

Negative and positive polarity   The MIN/MAX-account predicts that *erst* can license NPIs within the backgrounded part of the utterance, since *only* can, cf. (53-a) (from Beaver and Clark 2008: 187). The web example (53-b), with the NPI *einen Finger rühren*[14] shows that this is the case.

(53)   a.   [Faeries are] vicious, greedy buggers who'd *only* **lift a finger** to save their best friend if they thought they'd profit from it.
        b.   Der (Zahn-) Arzt **rührt** *(*erst*) **einen Finger**, wenn die Leistung bezahlt ist
             "The dentist/doctor doesn't lift a finger until the service is paid"

The MIN/MAX account does not predict that *erst* itself is a PPI, which was suggested e.g. in Karttunen (1974: 294), Giannakidou (2002: 11), and Condoravdi (2008: 633). Karttunen provides (54-a), which he claims to be infelicitous[15]. However, such examples are produced, e.g. (54-b)[16].

(54)   a.   *Die Prinzessin wachte **nicht** *erst* um 9 Uhr auf.
             "It is not the case that the princess didn't wake up until 9"
        b.   Somit kam ich **nicht** *erst* um 17 Uhr in Köln an (sondern schon um 15 Uhr)
             "Therefore I didn't only arrive in Köln at 5 p.m. (but already at 3 O'clock)"

---

[12]*Not...until* patterns like *erst* in this respect, as discussed e.g. in Karttunen (1974: 287).

[13]The formal analysis of these kinds of examples is left for further research. A puzzle for the MIN/MAX approach to *only* is why, if *at most* is in the scope of *only*, the scale is not reversed, leading to a different reading.

[14]From `http://www.forum-sicherheitspolitik.org/viewtopic.php?f=42&t=2026`. Other examples with e.g. the NPIs *brauchen*, *einen Mucks machen*, i.a. were found, but were omitted for reason of space. See also Declerck (1995: 67), who provides an example showing that *not...until* can license NPIs.

[15]I as a native speaker consider this example to be felicitous (to the extent that the preterite is felicitous).

[16]From `http://www.yasminarosawoelkchen.de/2013/08/mein-1-mal-koln-gamescom.html`. Again, other examples are omitted for reasons of space.

Condoravdi provides the example in (55-a), which is truly infelicitous. This infelicity is however due to the fact that the predicate needs to be negative but punctual, which it isn't, cf. (55-b), where an inchoative reading is coerced for the stative predicate *nicht anwesend sein* ("to not be present").

(55)   a.   *Die Bombe ist *erst* gestern **nicht** explodiert.
            "The bomb didn't not explode until yesterday"
       b.   (We expected Peter to start skipping school on Monday, but...)
            $^{(?)}$Peter war erst am Dienstag nicht anwesend.
            "It was not until Tuesday that Peter started skipping school" (lit. 'was not present')

I want to propose that the negation takes scope above *erst* in (54), but below *erst* in (55). Preliminary evidence for this comes from the respective order of *erst* and the negation[17]. More importantly, however, the relative scope of the negation and *erst* can account for the readings these sentences have: When the negation takes scope below *erst*, as in (55-b), all alternatives ranked on the scale are negative, cf. (56). *Erst* has its usual effect of negating 'earlier' alternatives. This is parallel to e.g. *Only Peter wasn't present*, which negates that there were more people not being present.

(56)

$$...$$

~~Peter started to not be present between t_{start} and Monday~~

Peter started to not be present between t_{start} and Tuesday

Peter started to not be present between t_{start} and Wednesday

$$...$$

When the negation scopes above *erst*, the alternatives are positive, cf. (57) for example (54-b). Due to the negation, the 1770-alternative is excluded as a candidate for the strongest true answer, leaving stronger, 'earlier' alternatives as remaining candidates (for parallel *only* examples, cf. §1.2).

---

[17]The scope of the German counterpart of durative *until*, *bis*, and negation is reflected in the word order. Condoravdi (2008: 634) proposes that a sentence like *Peter wasn't angry until yesterday* has two readings, a "throughout-not" reading, where the until phrase takes scope over the negation, and a "not-throughout" reading, where the negation takes higher scope. The former is expressed in German by (i), with the negation following the *bis* phrase, the latter by (ii), with the negation preceding the *bis* phrase.

(i)   Peter war **bis**   **gestern**   *nicht* wütend
       Peter was until$_{dur}$ yesterday not   angry
       "Until yesterday, Peter didn't get angry"   (throughout-not: UNTIL > NEG)

(ii)   Peter war *nicht* **bis**   **gestern**   wütend
       Peter was not   until$_{dur}$ yesterday angry
       "Peter didn't remain angry until yesterday"   (not-throughout: NEG > UNTIL)

(57)

> ...
> **I arrived between t$_{start}$ and 4**
> ~~I arrived between t$_{start}$ and 5~~
> I arrived between t$_{start}$ and 6
> ...

This section discussed some similarities between *erst* and *only*: (i) obligatory association with focus, disallowing association with weak pronouns, (ii) co-occurrence with *at most/at the earliest*, which strengthen the assertion that stronger alternatives are excluded, (iii) NPI licensing.

4. Summary and outlook

German *erst*, a temporal exclusive, was analysed using the MIN/MAX-account of Beaver and Clark (2008), Coppock and Beaver (2014): (i) it is scalar, i.e. the focus alternatives are ranked on a scale of strength, (ii) it has a presupposition leading to the exclusion of weaker alternatives (MIN), and (iii) an assertion leading to the exclusion of stronger alternatives (MAX). It differs from other exclusives in the properties predicted by Coppock and Beaver (2014): it takes an argument of type $\langle\langle i, st\rangle, \langle i, st\rangle\rangle$, requires a specialized QUD asking for the endpoint of an interval, and an entailment scale. In contrast to the similar accounts of Karttunen (1974), Condoravdi (2008), the proposal presented here thus provides a unified account for *erst* and other exclusive particles.

This paper however only discusses cases in which *erst* corresponds to *not...until* in English. There are numerous other examples in which *erst* can be used, which should be addressed in further work, e.g. the examples in (58)–(59), in which *erst* also excludes 'earlier' alternatives.

(58)   (We thought Paul had been sick longer, but...)   (59)   (I asked several people, but...)

Paul ist *erst* **seit** **Dienstag** krank.	Erst **Bea** hat geantwortet
Paul is PRT since Tuesday sick	PRT Bea has answered
"Paul has only been sick since Tuesday"	≈ "Bea was the first to answer"
	('earlier' people didn't!)

In example (58) is an instance of *erst* combining with a *seit*-PP ("since"). In these cases, the predicate must be durative, and stronger/'earlier' alternatives involve earlier *starting times* of the considered interval, cf. (60). The punctual/durative requirement and whether the endpoint or staring point of the interval is evaluated as 'late' thus depends on the PP argument. The cooccurrence of *erst* with different PP arguments should therefore be further explored (cf. also footnote 5).

The alternatives in example (59) involve potential answerers ordered by time, e.g. the (tentative) scale in (61), where Ali's potential answering time precedes Bea's, and Bea's precedes Cem's. It is excluded that earlier potential answerers actually answered, nothing is said about later answers.

(60)   ···   (61)   ···

~~P. is sick between Monday and t$_{end}$~~   ~~Somebody answered between t$_{start}$ and Ali~~

P. is sick between Tuesday and t$_{end}$ **Somebody answered between t$_{start}$ and Bea**

P. is sick between Wednesday and t$_{end}$ Somebody answered between t$_{start}$ and Cem

                                          ···   ···

While the scale and the effect of the MIN/MAX components are similar to the examples discussed in the preceding sections above, further work should elucidate how *erst* introduces this temporal interpretation, i.e. how the scale comes about.

Finally, future work should discuss the relation of the kind of *erst* involving "lateness" and another instance of *erst* involving "earliness" (cf. e.g. Löbner 1989, König 1991, and Krifka 2000, Karttunen 1974: 296 describes the same two readings for *vasta* in Finnish). For example, in (62), *erst* contributes the evaluation that it is earlier than expected. Under the current account, *erst* in (62) would have the usual *min/max* meaning components, and the scale would be like (63).

(62)   Es ist erst 9 Uhr.   (63)   ···
        "It is only 9 O'clock."
                                                                    ~~It is 10 O'clock~~
        P: It is at least 9 O'clock
        A: It is at most 9 O'clock   **It is 9 O'clock**

                                                                    It is 8 O'clock

                                                                            ···

It remains to be explained why both of these readings are expressed using *erst*, i.e. whether the common core of the different uses of *erst* is temporality, or whether further factors play a role.

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A compositional semantics for *wh-ever* free relatives[1]

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Abstract. This paper focuses on two puzzles posed by *wh-ever* free relatives ('FRs'): *wh-ever* FRs (a) license ignorance inferences, and (b) display properties in common with questions. I propose to resolve these puzzles by unifying the analysis of *wh-ever* FRs with Rawlins' (2008, 2013) analysis of unconditionals. The proposal derives ignorance, predicts question properties, and captures both the similarities and differences between *wh-ever* FRs and unconditionals.

Keywords: *wh-ever* free relatives, unconditionals, ignorance inferences

1. Introduction

This paper is concerned with the analysis of *wh-ever* FRs, as in (1). Following e.g. Jacobson (1995), a common approach is to analyze FRs as definite descriptions. This is illustrated in (2) with an FR without *ever*. *What Mary cooked* in (2a) has the same denotation as *the thing Mary cooked*, (2b). Extending this approach without modification to FRs with *ever*, however, leaves certain properties unexplained. This paper focuses on two puzzles.

(1)   John ate **whatever Mary cooked**.

(2)   a. John ate **what Mary cooked**.
       b. ⟦what Mary cooked⟧(w) = ιx [Mary cooked x in w]

1.1. Puzzle 1: Ignorance

Wh-ever FRs obligatorily license modal inferences of ignorance or indifference, illustrated in (3) with data from von Fintel (2000) (see also e.g. Dayal 1997, Iatridou & Varlakosta 1996, Tredinnick 2005, Lauer 2009, Condoravdi 2015).

(3)   a. Whatever Arlo is cooking has a lot of garlic.   (ignorance)
       b. I simply voted for whoever was at the top of the ballot.   (indifference)

The example in (3a) most naturally conveys that the speaker is ignorant about the identity of the thing(s) Arlo is cooking. (3b) does not require that the speaker be ignorant about the identity of the person they voted for, but rather conveys that the speaker voted for the person at the top of the ballot indiscriminately, indifferent to the identity of that person. I will focus on the ignorance reading and ask: how is ignorance derived? One approach in the literature localizes ignorance in the lexical semantics of *whatever*. Re-formulating Dayal (1997), von Fintel (2000) adopts the denotation for *whatever* in (4):

(4) ***Whatever(w)(F)(p)* presupposes (a), asserts (b)**

    a. $\exists w' \; \exists w'' \in F(w): \iota x \, [P(w')(x)] \neq \iota x \, [P(w'')(x)]$

    b. $\iota x \, [P(w)(x)]$

Whatever is a definite determiner, which triggers a modal presupposition. The presupposition says that a different entity is picked out by the definite description in at least two worlds in the modal base. With an epistemic modal base, this yields ignorance: (1) presupposes that Mary cooked different things in different epistemically accessible worlds and asserts that John ate the thing(s) Mary cooked in the evaluation world. My goal will be to provide an alternative account of ignorance which avoids construction-specific stipulation.

1.2. Puzzle 2: question-like properties

Wh-ever FRs display a cluster of properties in common with matrix questions (Richardson 1995, Gawron 2001, Rawlins 2010). Each of (5)-(8) constitutes a paradigm where (a) is a matrix question, (b) contains a definite description with a relative clause, and (c) contains a *wh-ever* FR. (a) and (c) pattern together to the exclusion of (b). An account of *wh-ever* FRs must resolve the question: why do *wh-ever* FRs display question-like properties?

(5) **Interrogative morphology**

    a. **What** did John eat?

    b. *John ate the food **what** Mary cooked?

    c. John ate **what** Mary cooked.

(6) ***Ever***

    a. What**ever** did John eat?

    b. *John ate the food which**ever** Mary cooked.

    c. John ate what**ever** Mary cooked.

(7) ***The hell***

    a. What **the hell** did John eat?

    b. *John ate the food what **the hell** Mary coked.

    c. John ate whatever **the hell** Mary cooked.

(8) ***Else***

    a. What **else** did John eat?

    b. *John ate the food which **else** Mary cooked.

    c. John ate whatever **else** Mary cooked.

1.3. Strategy for the present paper

My strategy to resolve the two puzzles will be to extend insights from the literature on unconditionals to the analysis of *wh-ever* FRs. In *wh-ever* FRs, a *wh-ever* XP occurs in argument position, as in (1), repeated in (9a). In unconditionals, a *wh-ever* XP appears as a free adjunct, (9b).

(9)   a. John ate **whatever Mary cooked**.   *(wh-ever FR)*

         b. **Whatever Mary cooked**, John had fun.   *(unconditional)*

Building on Rawlins' (2008, 2013) analysis of unconditionals, I will propose that the LF for *wh-ever* FRs has three ingredients: a question, a covert modal, and a definite description. The question and modal interact to derive ignorance (Puzzle 1), and question-like properties follow from the presence of a question in the LF (Puzzle 2). Motivation for the analysis will be provided.

2. Unconditionals

The two puzzles posed by *wh-ever* FRs — ignorance and question-like properties — similarly arise with unconditionals. An episodic unconditional like (9b) naturally conveys that Mary is ignorant about the identity of the thing(s) Mary cooked. The question-like properties in (5)-(8) also replicate in this and similar examples:

(10)   a. **What**ever Mary cooked, John had fun.   *(interrogative morphology)*

       b. What**ever** Mary cooked John had fun.   *(ever)*

       c. Whatever **the hell** John did, Mary will forgive him.   *(the hell)*

       d. Whatever **else** John did, Mary will forgive him.   *(else)*

Despite the parallels between *wh-ever* FRs and unconditionals, the two constructions have received quite different analyses. I spell out the analysis of unconditionals in Rawlins (2008, 2013). This analysis solves the two puzzles for unconditionals and, accordingly, serves as a useful starting point for an analysis of *wh-ever* FRs.

2.1. Rawlins (2008, 2013)

Rawlins pursues the intuition that (9b) analyzes as a conjunction of conditionals of the form in (11a), as in (11b). The analysis is spelled out in steps.[2]

(11) a. If Mary cooked x, John had fun.

  b. If Mary cooked **pizza**, John had fun, and if Mary cooked **pasta** John had fun, ...

Step 1: the *wh-ever* XP is a Hamblin question. Rawlins analyzes *whatever Mary cooked* as an interrogative CP, which denotes a set of propositions of the form λw . *Mary cooked x in w*, following Hamblin (1973).[3]

(12) ⟦whatever Mary cooked⟧

  a. $= \lambda p_{st}.\ \exists x\ [p = \lambda w$. Mary cooked x in w]

  b. $\{\lambda w.$ Mary cooked **pasta** in w, $\lambda w.$ Mary cooked **pizza** in w, ... $\}$

Step 2: the unconditional is a conditional. The second piece of Rawlins' analysis is to unify unconditionals with indicative conditionals like (13). After Lewis (1975), Kratzer (1977), and Heim (1982), the *if*-clause in (13) provides the restrictor for a covert necessity modal. The LF is (14a), with the modal defined as in (14b). The modal quantifies over worlds accessible from the world of evaluation according to some contextually provided accessibility function, F_c.

(13) If Mary cooked pasta, John had fun.

(14) a. [[□ Mary cooked pasta] John had fun]

  b. $\llbracket \square \rrbracket^c = \lambda p_{st}.\ \lambda q_{st}.\ \lambda w.\ \forall w' \in F_c(w)\ [p(w') \rightarrow q(w')]$ *(type $<st,<st,st>>$)*

---

[2] I have made some simplifications and notational modifications to accommodate space restrictions; for further details, I refer the reader to Rawlins (2013, §§2-3).

[3] For Hamblin, every node denotes a set and a question denotes a set of propositions. Composition principles, including Pointwise Functional Application (employed below), are then defined in such a way as to allow two sets to compose. To facilitate exposition, notation and prose in this paper will make a simplification and treat the characteristic function for a set as interchangeable with the set characterized. (12a) provides the characteristic function for a set of propositions. For relevant further discussion, see e.g. Rawlins (2008; Appendix 3-A).

The restrictor argument for the modal in (14a) is provided by *Mary cooked pasta* and the scope is provided by *John had fun*. The predicted meaning is (15):

(15) $[\![\Box]\!]^c(\lambda w.\ \text{Mary cooked pasta in } w)(\lambda w.\ \text{John had fun in } w)$
  $= \lambda w.\ \forall w' \in F_c(w)\ [\text{Mary cooked pasta in } w' \rightarrow \text{John had fun in } w']$

Rawlins proposes that the LF for an unconditional like (9b) similarly contains a covert necessity modal. The *wh-ever* CP provides the restrictor of the modal, per the structure in (16).

(16) **LF for (1):**   [[$\Box$ whatever Mary cooked] John had fun]

Step 3: the *wh-ever* CP pointwise restricts the modal. Recall from (12) that *whatever Mary cooked* denotes a set of propositions of the form λw . *Mary cooked x in w*. Recall from (14b) that the modal requires a proposition as its restrictor argument. *Whatever Mary cooked* and the modal compose via Pointwise Functional Application (e.g. Hamblin 1973, Kratzer & Shimoyama 2002): each proposition in the set in (12) is taken as the restrictor of the modal in (14b) to derive:

(17) $[\![\Box \text{ whatever Mary cooked}]\!]^c$
  a. $= \lambda P_{<st,st>}.\ \exists x\ [P = \lambda q_{st}.\ \lambda w.\ \forall w' \in F_c(w)\ [\text{Mary cooked x in } w' \rightarrow q(w')]]$
  b. $\{\lambda q_{st}.\ \lambda w.\ \forall w' \in F_c(w)\ [\text{Mary cooked } \textbf{pasta} \text{ in } w' \rightarrow q(w')],$
        $\lambda q_{st}.\ \lambda w.\ \forall w' \in F_c(w)\ [\text{Mary cooked } \textbf{pizza} \text{ in } w' \rightarrow q(w')], ... \}$

The proposition provided by *John had fun* is then taken pointwise as the argument of each element of (17) to deliver (18). Each element of (18) is a modalized proposition. Given that conditionals are just modalized propositions, each is a conditional, as in the idiomatic re-formulation in (19).

(18) $[\![\Box \text{ whatever Mary cooked John had fun}]\!]^c$
  a. $= \lambda p_{st}.\ \exists x\ [p = \lambda w\ .\ \forall w' \in F_c(w)\ [\text{Mary cooked x in } w' \rightarrow \text{John had fun in } w']]$
  b. $\{\lambda w.\ \forall w' \in F_c(w)\ [\text{Mary cooked } \textbf{pasta} \text{ in } w' \rightarrow \text{John had fun in } w'],$
        $\lambda w.\ \forall w' \in F_c(w)\ [\text{Mary cooked } \textbf{pizza} \text{ in } w' \rightarrow \text{John had fun in } w'], ... \}$

(19) $\{$if Mary cooked **pasta**, John had fun, if Mary cooked **pizza**, John had fun, ...$\}$

Step 4: converting to a single proposition. Since (9b) does not intuitively denote a set of propositions, but rather a single proposition, an additional operator is necessary. Rawlins adopts an operator which takes a set of propositions as its argument and asserts that every proposition in that

set is true. I will refer to this operator as 'Op'. The updated LF for (9b) is (21), in which Op takes highest scope. Op applies to the set of propositions in (18) to deliver the final meaning for (9b) in (22) — in effect, a conjunction of conditionals of the form *if Mary cooked x, John had fun*.

(20) $[\![\text{Op}]\!] = \lambda P_{<st,t>}.\ \lambda w.\ \forall p\ [P(p) \to p(w)]$

(21)   **Updated LF for (1):**   [Op [[□ whatever Mary cooked] John had fun]]

(22) $[\![(9b)]\!]^c$

   a. $= \lambda w.\ \forall p\ [\exists x\ [p = \lambda w'.\ \forall w'' \in F_c(w')\ [\text{Mary cooked x in w''}$
   $\to \text{John had fun in w''}]] \to p(w)]$

   b. $= \lambda w.\ \forall w' \in F_c(w)\ [\text{Mary cooked } \textbf{pasta} \text{ in w'} \to \text{John had fun in w'}]\ \&$
   $\forall w' \in F_c(w)\ [\text{Mary cooked } \textbf{pizza} \text{ in w'} \to \text{John had fun in w'}]\ \& ...$

2.2. Resolving the puzzles

Rawlins' analysis resolves for unconditionals the two central puzzles of concern in this paper. Because the *wh-ever* XP is a question, it is unsurprising that the *wh-ever* XP displays question-like properties. Regarding ignorance, the analysis makes it possible to derive ignorance without construction-specific stipulation, but this requires more demonstration.

2.2.1. Deriving ignorance

Rawlins makes two assumptions which together provide the necessary pieces to derive ignorance. First: an assumption about the elements of the set provided by the *wh-ever* CP. Rawlins assumes that the propositions in the set are presupposed to be mutually exclusive relative to the context set: at any given world in the context set, at most one proposition holds. For exposition, I will indicate this by modifying the set shown in (12) above for *whatever Mary cooked* as in (23):

(23) $[\![\text{whatever Mary cooked}]\!]$

   a. $\approx \{\lambda w.$ Mary cooked only **pasta** in w,

   b. $\lambda w.$ Mary cooked only **pizza** in w),

   c.   ...}

Each alternative is interpreted exhaustively: (23a) says that Mary cooked *only* pasta; (23b) says that Mary cooked *only* pizza; and so forth. The propositions are mutually exclusive.

The second assumptions has to do with the modal. Rawlins assumes that the modal is subject to a non-triviality presupposition, which requires that there be some world in the modal base at

which the restrictor argument is true. Where $F_c(w)$ is the modal base and p is the set of world characterized by the restrictor argument, the non-triviality presupposition may be stated:

(24) **Non-triviality presupposition**
      $F_c(w) \cap p \neq \emptyset$

The only addition needed to derive ignorance is one other assumption about the modal: that the modal base is epistemic. $F_c(w)$ is the set of worlds compatible with the speaker's beliefs at the evaluation world, (25). With an epistemic modal base, the non-triviality presupposition requires that p be true at some epistemically accessible world.

(25) **Epistemic modal base**
      $F_c(w) = \{w' : w'$ is compatible with the speaker's beliefs in $w\}$

The critical point in the computation for the derivation of ignorance is Step 3, where the *wh-ever* CP composes with the modal. Each proposition in the set provided by *whatever Mary cooked* — i.e. (23) — is taken pointwise as the restrictor argument of the modal. This interacts with the non-triviality presupposition in such a way as to derive the overall presupposition for (9b) in (26).

(26) **Predicted presupposition of (9b)**

      a. $F_c(w) \cap \{w' :$ Mary cooked only **pasta** in $w'\} \neq \emptyset$

      b. & $F_c(w) \cap \{w' :$ Mary cooked only **pizza** in $w'\} \neq \emptyset$

      c. & ...

Taking (23a) as the restrictor of the modal triggers a presupposition that Mary cooked only pasta at some epistemically accessible world, (26a); taking (23b) as the restrictor triggers a presupposition that Mary cooked only pizza at some epistemically accessible world, (26b); and so forth. I take it that each of these triggered presuppositions projects.

Let us focus on the presuppositions in (26a) and (26b): it is epistemically possible that Mary cooked only pasta, and it is epistemically possible that Mary cooked only pizza. How can this conjunctive presupposition be satisfied? The only way is for the speaker to be ignorant about the identity of the thing Mary cooked: given the speaker's beliefs, it must be a live possibility that the thing Mary cooked is pasta, and a live possibility that the thing Mary cooked is pizza. The ignorance inference in (9b) straightforwardly obtains.

2.3. Summary

This section has presented Rawlins' analysis of unconditionals, and demonstrated that this analysis can resolve our two central puzzles for *wh-ever* constructions: ignorance, and question-like properties. The goal now is to extend Rawlins' analysis for unconditionals to *wh-ever* FRs.

3. Extending to *wh-ever* FRs

3.1. Bridging from unconditionals to *wh-ever* FRs

As a first step towards extending to *wh-ever* FRs, consider the unconditional in (27a), which has a parallel interpretation to the *wh-ever* FR in (1), repeated as (27b). In (27a), there is a pronoun in argument position whose interpretation intuitively co-varies with that of the *wh-ever* XP.

(27)   a. Whatever Mary cooked, John ate it.

        b. John ate whatever Mary cooked.   =*(1)*

A natural hypothesis for (27a) would analyze *it* as an individual variable bound by *whatever Mary cooked*. This is not, however, consistent with Rawlins' approach: *whatever Mary cooked* denotes a set of propositions, so is not of the right type to bind an individual variable. Rather, the correct meaning is predicted for (27a) in a way consistent with Rawlins' analysis if *it* is analyzed not as a bound variable, but as an E-type pronoun with the denotation in (28). The Rawlins-style LF for (27a) is (29), and (27a) is interpreted as the conjunction of conditionals in (30).

(28)   ***It* = E-type pronoun:** $[\![\text{it}]\!](w) = \iota x$ [Mary cooked x in w]

(29)   **LF for (27a):** $[[\Box$ whatever Mary cooked] John ate ιy [Mary cooked y in w']]

(30) $\lambda p. \exists x [p = \forall w' \in F_c(w)$ [Mary cooked only x in w' $\rightarrow$ John ate ιy [Mary cooked y in w']]]

The world variable in the E-type pronoun is bound by the modal in (30). Because the modal has a different restrictor in each conditional in the set characterized, it follows that the referent of the E-type pronoun varies between the conditionals. Consider the idiomatic paraphrase of (27a):

(31)   a.   If Mary cooked only **pasta** in w', Mary ate the thing(s) Mary cooked in w',

        b. & if Mary cooked only **pizza** in w', Mary ate the thing(s) Mary cooked in w',

        c. & ...

The conditional in (31a) says: in all accessible w' at which Mary cooked only pasta, John ate the thing(s) Mary cooked at w' — i.e. the E-type pronoun refers to pasta. (31b) says: in all accessible w' at which Mary cooked only pizza, John ate the things that Mary cooked at w' — i.e. the E-type pronoun refers to pizza. In this way, the correct interpretation obtains: (27a) says that for every *x*, in all accessible worlds at which Mary cooked only *x*, John ate *x*.

Given the intuitive parallel between (1) and (27a), I will pursue the hypothesis that *wh-ever* FRs like (1) and unconditionals like (27a) have a uniform analysis ('Unification Hypothesis').

3.2. Extending to *wh-ever* FRs

The empirical focus now shifts to (1) itself (*John ate whatever Mary cooked*). At first, the Unification Hypothesis appears to be a non-starter. Since a *wh-ever* XP denotes a set of propositions in Rawlins' analysis and *ate* requires an individual first argument, (1) should be uninterpretable due to a type-mismatch. *Whatever Mary cooked* has the denotation in (32a) and *ate* has the denotation in (32b), and these cannot compose, (32c).

(32) **Type-mismatch in (1)**

    a. $\llbracket$whatever Mary cooked$\rrbracket = \lambda p_{st}. \exists x [p = \lambda w.$ Mary cooked x in w$]$ *(<st,t>)*

    b. $\llbracket$ate$\rrbracket = \lambda x. \lambda y. \lambda w.$ y ate x in w   *(<e,<e,st>>)*

    c. $\llbracket$ate$\rrbracket(\llbracket$whatever Mary cooked$\rrbracket)$ *Type-mismatch!*

Hence, the basic compositional challenge: how can the *wh-ever* XP in (1) be interpreted as restricting a covert modal, and how can there be a definite description in argument position equivalent to E-type *it* in (27a)?

Step 1: Spelling out the internal composition of questions. We have taken an interrogative like *whatever Mary cooked* itself to denote a set of propositions. I will now revise this assumption: an interrogative CP does not denote a set of propositions, but rather a property (e.g. Groenendijk & Stokhof 1989, Jacobson 1995, Caponigro 2004, Rawlins 2010, George 2011). Consider (33a), with the structure in (33b):

(33) **LF for an interrogative CP**

    a. What did Mary cook?

    b. [$_{CP}$ what [$_{TP}$ λ1 Mary cooked t$_1$]]

Following Caponigro (2004), *what* has the property meaning in (34a). *What* composes with the derived property in (34b) via Predicate Modification to yield the property meaning for the inter-

rogative CP in (34c): an individual is mapped to the proposition that that individual is inanimate and Mary cooked that individual. To facilitate discussion, I will simplify (34c) as (34d).

(34) a. $\llbracket$what$\rrbracket = \lambda$x. λw. x is inanimate in w   *($<$e,st$>$)*

      b. $\llbracket$TP$\rrbracket = \lambda$x. λw. Mary cooked x in w   *($<$e,st$>$)*

      c. $\llbracket$CP$\rrbracket = \lambda$x. λw. x is inanimate in w & Mary cooked x in w   *($<$e,st$>$)*

      d. $\approx \lambda$x. λw. Mary cooked x in w

A covert Q morpheme is responsible for converting the property meaning in (34d) into a set of propositions (George 2011). Q is defined as in (35) and, as a component of its meaning, existentially closes the open individual argument slot in its input property. The updated LF for (33a) containing Q is shown in (36a); Q applies to the property in (34d) as shown in (36b).

(35) **Defining Q**
      $\llbracket$Q$\rrbracket = \lambda$f$_{<e,st>}$. λp$_{st}$. $\exists$x [p = λw. f(x)(w)]

(36) **Incorporating Q into (33)**

      a. [$_{QP}$ Q [$_{CP}$ what [$_{TP}$ λ1 Mary cooked t$_1$]]]

      b. $\llbracket$QP$\rrbracket = \llbracket$Q$\rrbracket(\llbracket$CP$\rrbracket)$
          $= \lambda$p$_{st}$. $\exists$x [p = λw. Mary cooked x in w]

Given these assumptions about the composition of a question, some housekeeping is needed for the LF for the unconditional in (27a). The revised LF is (37). The critical change: the sister of the modal is not a bare interrogative CP, but rather is now a QP, which embeds the interrogative CP.[4]

(37) **Updated LF for (27a):**
      [[$\square$ [$_{QP}$ Q [$_{CP}$ whatever Mary cooked]]] John ate ιy [Mary cooked y in w']][5]

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[4]As discussed in fn. 3, I have treated a set of propositions as interchangeable with its characteristic function to facilitate exposition. If the two are kept separate and Pointwise Functional Application is defined as an operation between two sets (as in Hamblin 1973), in order for the QP to pointwise compose with the modal, the QP must denote the set characterized in (36b). In Hamblin's framework where every node denotes a set, the composition advocated here could be implemented as follows to output a set. Differing from Hamblin's own internal composition of a question, $\llbracket$*what*$\rrbracket$ = {λx . λw . x is inanimate in w}, which composes with {λx . λw . Mary cooked x in w} via Predicate Modification to derive $\llbracket$QP$\rrbracket$ = {λx . λw . x is inanimate in w & Mary cooked x in w} $\approx$ {λx . λw . Mary cooked x in w}. Q would then be defined syncategorematically: the sister of Q must be a singleton set α containing a property — schematically, α = {f$_{est}$} — and $\llbracket$Q$\alpha$$\rrbracket$ = {p : $\exists$x [p = f(x)]}. As such, $\llbracket$QP$\rrbracket$ = {p : $\exists$x [p = λw. Mary cooked x in w]}, the set characterized in (36b).

[5]Although I indicate *ever* within the interrogative CP, I in fact remain agnostic as to whether *ever* and other operators characteristic of questions like *the hell* and *else* operate within the interrogative CP or operate on the QP.

<u>Step 2: questions and definite descriptions have a common core.</u> Given the analysis of questions just presented, questions and definite descriptions are compositionally quite similar: each involves an operator being applied to a property (cf. Jacobson 1995, Caponigro 2004). This is brought out in directly comparing (38) with (39):

(38) **Question: apply Q to a property**

    a. What did Mary cook?

    b. $[\![Q]\!](\lambda x.\ \lambda w.\ \text{Mary cooked x in w})$
 $= \lambda p_{st}.\ \exists x\ [p = \lambda w.\ \text{Mary cooked x in w}]$

(39) **Definite description: apply *the* to a property**

    a. the (thing) Mary cooked

    b. $[\![\text{the}]\!](\lambda x.\ \lambda w.\ \text{Mary cooked x in w})(w)$
       $= \iota x\ [\text{Mary cooked x in w}]$

In (38), Q applies to a property to derive a set of propositions; in (39), *the* applies to that same property to derive a definite description.

<u>Step 3: building the LF for (1).</u> The key proposal is that, in *wh-ever* FRs, the property contributed by the *wh-ever* CP forms *both* the core of a question, and the core of a definite description. There are different ways the proposal can be modeled, but I will opt for a syntactic structure involving multi-dominance, which offers a particularly intuitive illustration.[6] The structure for (1) is (40):

(40) **Structure for (1)**
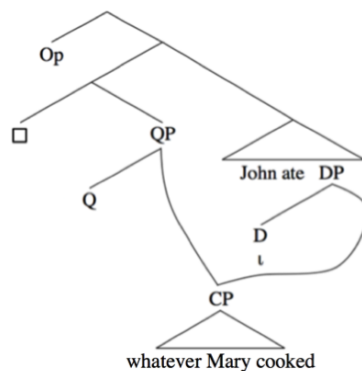
The interrogative CP *whatever Mary cooked* is multiply dominated; in effect, it occurs in two positions. It is dominated by a QP in the restrictor position of the modal, and by a DP in argument

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[6]The proposal could also be modeled with a movement derivation, rather than multi-dominance. Space restrictions preclude discussion.

position. In the QP, the sister of *whatever Mary cooked* is the covert Q morpheme, which converts the property meaning to a set of propositions, as in (38) above. In the DP, the sister of *whatever Mary cooked* is a covert definite determiner (ι), which converts the same property meaning to a definite description, as in (39).[7]

Unification is achieved. The LF for the *wh-ever* FR (1) in (40) is parallel to the LF for the unconditional (27a) in (37). In each case, a modal is pointwise restricted by a set of propositions provided by *[Q whatever Mary cooked]* and, in argument position, there is a definite description ιx *[Mary cooked x in w']*. The only difference between (27a) and (1) is in how the definite description comes about. In (27a), *whatever Mary cooked* is just the sister of Q in the restrictor of the modal, and the definite description is contributed by E-type *it*. In (1), *whatever Mary cooked* is the sister of Q, but also is itself definitized in argument position. Two issues require further comment.

3.2.1. Pronouncing (40)

How does the structure in (40) correspond to the pronounced string in (1)? I take it that the multiply dominated constituent, *whatever Mary cooked*, is spelled out just once, in its rightmost position. This is consistent with other constructions which have been analyzed with multi-dominance, as illustrated in (41) with Right Node Raising[8]:

(41)   John likes and Mary hates [the Scottish play].

According to multi-dominance analyses of (41), a single occurrence of *the Scottish play* is both the sister of *likes* in the left conjunct and the sister of *hates* in the right conjunct (e.g. Wilder 1999, Bachrach & Katzir 2009). *The Scottish play* is pronounced once, in its rightmost position.

3.2.2. Existence presupposition

An aspect of the meaning of *wh-ever* FRs which I have thus far not discussed is that they trigger an existence presupposition: (1) presupposes that Mary cooked something at the actual world. This is brought out in (42): the *although*-clause in (42) denies that Mary cooked anything and the sentence is degraded.

(42)   #Although it's possible that Mary didn't cook anything, **John ate whatever Mary cooked**.

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[7]The structure in argument position is similar to that proposed for FRs without *ever* in Caponigro (2002), where he takes the *wh* XP to be a CP embedded by a covert D. The external syntax of *what(ever) Mary cooked* is that of a DP, consistent with the presence of the DP layer. A further issue concerns the "matching" effect that the external syntactic category of an FR matches that of the *wh* word within the FR. See Caponigro (2002) for an approach.

[8]See also Johnson (2010), Johnson & Fox (2015) on Quantifier Raising.

It has been argued that matrix *wh*-questions also carry an existence presupposition: the question *What did Mary cook?* presupposes that Mary cooked something. (43) is adapted from Postal (1971) (see also e.g. Karttunen & Peters 1976, Comorovski 1996):

(43)   #Although it's possible that Mary didn't cook anything, **what did Mary cook?**

Since the LF for (1) contains the question *[Q whatever Mary cooked]*, the existence presupposition in (1) comes about in a similar way to the existence presupposition of the corresponding matrix *wh*-question: it is presupposed that some proposition of the form λw . *Mary cooked x in w* in the set provided by the question is true at the actual world. I remain agnostic about the compositional source of this presupposition, except to note that the issue in *wh-ever* FRs reduces to the same issue in matrix *wh*-questions.[9]

3.3. Summary

This section has developed a proposal extending Rawlins' analysis of unconditionals to *wh-ever* FRs. The *wh-ever* CP denotes a property. That property does double duty, forming both the core of a question, and the core of a definite description. The question pointwise restricts a covert modal, and the definite description occurs in argument position. I provided one way to model the proposal, using a multi-dominance structure. I now demonstrate how the proposal offers a perspective on a range of further data.

4. Prediction #1: Asymmetries between unconditionals and *wh-ever* FRs

There is apparent counter-evidence to the hypothesis that unconditionals and *wh-ever* FRs have a uniform analysis. I will focus on one asymmetry: multiple *wh* constructions are acceptable in unconditionals, but not in *wh-ever* FRs. This is illustrated in (44), with an example discussed in Rawlins (2013:150) (see also e.g. Izvorski 2000, Gawron 2001, Grosu 2003, Rawlins 2013, i.a.).

(44)   **Multiple *wh*: unconditional (a) vs. *wh-ever* FR (b)**

    a. (?)Whoever said what to whom, we've got to put this behind us.[10]

   b. *John talked to whoever said what to whom.

The observed asymmetry in fact follows as a prediction of the proposal. Despite the Unification Hypothesis, there is an important difference between the LF for an unconditional and the LF for a

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[9]Rawlins observes a similar existence inference with unconditionals and encodes the existence requirement in a question operator.

[10]The example is originally from Huddleston & Pullum (2002).

wh-ever FR. In an unconditional, the *wh-ever* CP itself is only the argument of the Q morpheme in the restrictor of the modal. In an argument *wh-ever* FR, the *wh-ever* CP is both the argument of Q and the argument of ι in argument position. The structures for (44a) and (44b) are (45) and (46), respectively:

(45)   **Structure for (44a)**
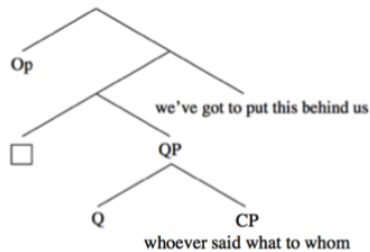
(46)   **Structure for (44b)**
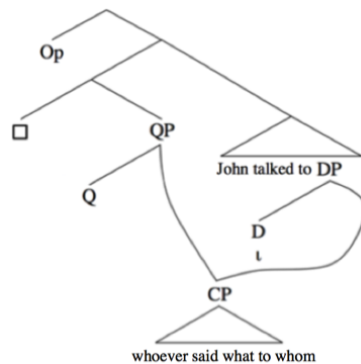
It is clear from the existence of multiple *wh*-questions, like (47), that Q must be defined in such a way that it can compose with a multi-place predicate.

(47)   a.   Who said what to whom?

     b.   [$_{QP}$ Q [$_{CP}$ who said what to whom]]

The interrogative CP in (47) has three open individual arguments, as in (48a). Q must compose with the predicate in (48a) to deliver a set of propositions of the form λw . *x said y to z in w*. This means that Q must existentially close all of the unsaturated individual argument slots in its input predicate, as in (48b). George (2011) provides an analysis of Q which achieves this result.

(48)   a.   ⟦who said what to whom⟧ = λx. λy. λz. λw. x said y to z in w

        b.   ⟦Q⟧(⟦who said what to whom⟧) = λp. $\exists$x $\exists$y $\exists$z [p = λw. x said y to z in w]

Different from Q, the ι operator, like the overt definite determiner, can inflexibly combine only with a predicate with one unsaturated individual argument slot. The contrast between (44a) and (44b) now follows straightforwardly. The structure in (45) is interpretable, since *whoever said what to whom* is just the argument of Q. In (46), on the other hand, problems arise because *whoever said what to whom* is the argument of ι, as well as Q. *Whoever said what to whom* cannot compose with ι due to a type-mismatch: ι requires an $<$e,st$>$ first argument, and *whoever said what to whom* is of type $<$e,$<$e,$<$e,st$>>>$. The type-mismatch renders (44b) ungrammatical.

5. Prediction #2: Variable binding

Consider the possibility of a variable binding relationship between a subject quantifier and a pronoun in an object *wh-ever* FR. The baseline is (49), where the subject is *no boy*, and the *wh-ever* FR does not contain a pronoun. This example is natural on an ignorance reading: (49) may convey that no boy ate the thing Mary cooked, with the speaker ignorant about the identity of that thing.

(49)   No boy ate whatever Mary cooked.

The critical datum is (50), where *his* is inserted into the *wh-ever* FR and bound by *no boy*. Informants report (50) as deviant on an ignorance reading: (50) cannot convey the conjunction of (51a) and (51b). To bring this out, suppose the speaker knows that a party happened last night where every boy's mother brought a dish and the speaker knows that no boy ate his mother's dish, but the speaker is uncertain about the identity of the dishes. (50) does not seem a natural utterance.[11]

(50)   No boy_1 ate whatever his_1 mother cooked.   (* on ignorance reading)

(51)   a.   For no boy *x* did *x* eat the thing *x*'s mother cooked.

        b.   For every boy *x*, the speaker is ignorant about what *x*'s mother cooked.

The deviance of (50) is predicted under the present proposal, and the bearing out of this prediction provides evidence for the posited covert epistemic necessity modal. The derivation for (50) is illustrated in (52). For *no boy* to bind *his* in the CP, *no boy* must c-command the CP in both positions where it occurs. From subject position, *no boy* c-commands the CP in its position sister

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[11]Note that some informants report variable binding to be improved if *no* is replaced by *every*, as in: *Every boy_1 ate whatever his_1 mother cooked*. One possibility is that the example with *every* involves telescoping, rather than variable binding — but further work is needed to verify that the proposal made here for (50) fully generalizes.

to D, but not in its position sister to Q. *No boy* must move to a position where it c-commands the QP, which means undergoing QR to a position above the modal. The structure in (52) shows the output of this QR. In (52), *no boy* is above the modal and binds both *his* and its trace left in subject position.

(52)   **Structure for (50)**
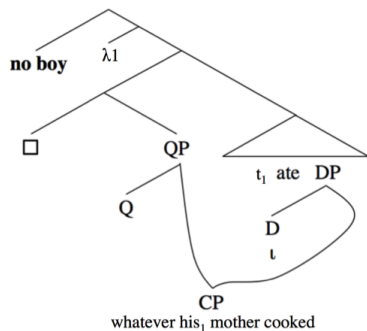
Given that the modal is epistemic on an ignorance reading, the configuration in (52) is in violation of the Epistemic Containment Principle, from von Fintel & Iatridou (2003):[12]

(53)   **Epistemic Containment Principle ('ECP')**
       A quantifier cannot bind its trace across an epistemic modal.

No boy in (52) is above the modal and its trace is below the modal, so the ECP is violated. The ungrammaticality of (50) follows from the violation of the ECP.[13]

Under an approach to *wh-ever* FRs like that in von Fintel (2000) (cf. (4) in §1.1), it is difficult to see why (50) would be deviant. Recall that von Fintel analyzes *whatever* as a definite determiner and localizes modality in a presupposition of *whatever*. The LF for (50) on this analysis would be:

(54)   **LF for (50) by von Fintel (2000):**   [no boy λ1 ate [whatever his$_1$ mother cooked]]

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[12]In moving above the modal, *no boy* moves across *his* as it occurs within the QP sister to the modal, so binding in (50) would be in violation of Weak Crossover, as well.

[13]Note that the effect in (50) is restricted to ignorance. (50) can acceptably convey that the no child ate the thing that his mother cooked, indifferent to its identity. This is brought out in: *No child (simply) ate whatever his mother cooked. They demanded good food.* The asymmetry between ignorance and indifference seems consistent with the proposal. To derive the indifference reading, the modal would have a counterfactual, rather than epistemic modal base. The ECP would not apply, and counterfactual modals may be lower in the structure than epistemic modals, so Weak Crossover may not be violated. That said, I leave a proper treatment of indifference to future research.

Whatever his mother cooked is a definite description, so is interpretable as the complement of *ate*, and *no boy* binds *his* from subject position. Since modality is introduced as a presupposition of *whatever*, within the complement of *ate*, *no boy* clearly does not bind a trace across an epistemic modal, and no ECP violation is incurred.

6. Conclusion and outlook

This paper has proposed to extend Rawlins' (2008, 2013) analysis of unconditionals to *wh-ever* FRs (§3) and, in doing so, has accounted for our two central puzzles, as well as further properties:

- *Wh-ever* FRs give rise to ignorance inferences (Puzzle 1; §2.2.1).

- *Wh-ever* FRs display question-like properties (Puzzle 2; §2.2).

- *Wh-ever* FRs, unlike unconditionals, disallow multiple *wh* constructions (§4).

- Subject quantifiers cannot bind a pronoun in an object *wh-ever* FR with ignorance (§5).

The present paper leaves a number of questions open for future research, two of which I flag. Question 1: how to derive indifference readings? In addition to the ignorance readings analyzed in this paper, *wh-ever* FRs allow indifference readings (recall ex. (3b)). Building on von Fintel (2000), indifference may involve counterfactual modality. This can be accommodated in the proposed framework by changing the modal base from epistemic, as assumed to derive ignorance, to counterfactual. This extension remains to be fully worked out. Question 2: how to capture cross-linguistic variation? To derive the meaning of a *wh-ever* FR, a property must do double duty, both forming the core of a question and the core of a definite description. How the property is built syntactically, however, is a potential locus of variation within and between languages. In English, I have taken the syntactic source for the property to be an interrogative CP. This is supported by the question-like properties observed above — as well as by (55a) and (55b): an overt complementizer *that* cannot intervene between *whatever* and the rest of the clause; and the rest of the clause cannot extrapose, stranding *whatever*. Interrogative CPs display the same properties, (56).

(55)   a.   *John ate whatever that Mary cooked.
       b.   *John ate whatever yesterday that Mary cooked.

(56)   a.   *Bill asked [what that John ate].
       b.   *Bill asked [what yesterday that John ate].

Languages employ a range of strategies to construct *ever* free relatives, however, and variation in the syntax of how the property is built may provide a useful starting point to approach this typology.

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A Hamblin Semantics for Alternative Questions in Yoruba[1]

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Abstract. Alternative and polar question interpretations of disjunctive questions in Yoruba (Niger-Congo, Nigeria) are syntactically disambiguated by obligatory fronting of the disjunction in the case of alternative but not of polar questions to a focus position at the left edge of the clause. This paper investigates the role of focus fronting and the accompanying focus particle *ni* in the compositional derivation of the alternative question set as well as for the triggering of a presupposition requiring mutual exclusivity of the two alternative propositions in the question set. The main claim is that movement to a designated focus position licenses the generation of alternatives which compose with the rest of the material in the question via Hamblin Function Application to derive an alternative question interpretation. The focus particle *ni* is argued to contribute a homogeneity presupposition both in alternative questions and elsewhere in the language which, when applied pointwise to each alternative in the question set, derives the mutual exclusivity requirement. The proposal developed here for Yoruba supports a view under which focus (marking the generation of alternatives) plays a stable role in deriving alternative question interpretations crosslinguistically, but differences in the semantic contribution of focus markers may yield subtle differences in the presuppositions they carry.

Keywords: Disjunctive Questions, Alternative Semantics, Crosslinguistic Variation

1. Introduction

The observation that disjunctive questions like (1) are associated with two kinds of interpretations, illustrated by the paraphrases in (1-a) and (1-b), is remarkably stable crosslinguistically (cf. (Beck & Kim 2006) for Korean, (Erlewine 2014) for Mandarin, (Uegaki 2014) for Japanese and by now a number of proposals have been made to explain how these two interpretations are derived compositionally (for a recent overview see Biezma & Rawlins 2015).

(1)   *Did Kemi buy the shoes or a book?*
  a.   I want to know which of the two Kemi bought   Alternative Question (AltQ)
  b.   I want to know whether she bought one of the two.   Polar Question (PolQ)

This paper contributes data from Yoruba, a language in which AltQ and PolQ interpretations are syntactically disambiguated, to the empirical landscape and evaluates two major approaches to the compositional semantics of disjunctive questions with respect to how well they can capture the pat-

tern of AltQ and PolQ interpretations in Yoruba. The first is the quantificational analysis developed in Larson (1985) and more recently defended by Nicolae (2013) while the second is an alternative semantic one argued for by Beck & Kim (2006), Erlewine (2014) and Biezma & Rawlins (2015). We argue that an alternative semantic approach is best suited to the Yoruba data for two reasons: Firstly, because it can provide an explanation for the one-to-one correspondence between focus fronting and alternative question interpretations, under the assumption that alternative-introducing constituents (including wh-pronouns and foci) obligatorily undergo fronting to a designated focus position. Secondly, it explains the interference of focus sensitive elements with the generation of AltQ interpretations, known as intervention effects (Beck 2006, Beck & Kim 2006), which remain unexplained by the quantificational approach. The paper also considers how mutual exclusivity presuppositions (cf. Biezma & Rawlins 2012) arise under the chosen account of alternative questions. We suggest that the focus particle *ni*, which obligatorily follows material that has undergone focus fronting in Yoruba, is responsible for the generation of this inference, via the introduction of a homogeneity presupposition modelled on the one proposed for English it-clefts by Büring & Križ (2013). We argue that, while the role of focus in generating the alternatives needed for an AltQ interpretation is crosslinguistically stable, the semantic contribution of the focus marker may be variable crosslinguistically, leading to variability in the presuppositions associated with alternative questions. The paper is structured as follows:

Section 2 presents the data on disjunctive questions in Yoruba: 2.1 on when AltQ and PolQ interpretations are available together with assumptions about their underlying syntax and 2.2 on the presuppositions carried by Yoruba AltQs. Section 3 spells out how the quantificational and alternative semantic analyses could be implemented for Yoruba (in 3.1 and 3.2 respectively) and then discusses evidence in favour of the alternative semantic approach (in 3.3). Section 4 develops a proposal for deriving the mutual exclusivity presupposition of AltQs via a homogeniety presupposition and then provides evidence for the claim that this presupposition comes from the focus particle *ni* . Section 5 concludes by considering the crosslinguistic picture.

2. Core Data

2.1. Building Alternative and Polar Questions in Yoruba

In Yoruba disjunctive questions, the syntactic position of the disjunction and presence or absence of a focus-marking particle, *ni*, determines whether a polar or alternative question interpretation is generated[2]: If the disjunction occurs in its canonical position, the question is unambiguously inter-

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[2]In order to determine which interpretations were available for each syntactic configuration, two tests were used: The first was felicitous answers: If a question could be felicitously answered with *yes* or *no* (in an appropriate context), then it was taken to have a polar question interpretation. The second was felicity in a context where an answer to a PolQ interpretation would be uninformative, as in (i): If a question was felicitous in such a context it was deemed to have an alternative question interpretation.

(i)   Context for (1): You know one of your two daughters, Adebimpe and Kemi, bought an adire [tye-dyed cloth] but you don't know which one. You ask...

preted as a polar question, as in (2-b)[3] and (3-b). When the disjunction occurs at the left edge of the clause, following a question particle and followed by a focus-marking particle, as in (2-a) and (3-a), the question is unambiguously interpreted as an alternative question. This generalization is further supported by the fact that disjunctive questions which only allowed for an alternative question reading, because the two alternatives partition the space of logical possibilities, are rejected as unacceptable by native speakers when the disjunction is in its canonical position, (4-a). In these cases only the fronted form, (4-b), is acceptable.

(2)   a.   *Ṣe* [$_{DisjP}$ *bata   tabi iwe*] ***ni*** *Kemi ra?*
             Q   shoes or   book FOC Kemi buy
             "Did Kemi buy the SHOES or the BOOK?"   (AltQ✓; PolQ#)

       b.   *Ṣe Kemi ra* [$_{DisjP}$ *bata   tabi iwe*]?
             Q Kemi buy   shoes or   book
             "Did Kemi buy shoes or a BOOK?"   (AltQ#, PolQ✓)

(3)   a.   *Ṣe* [$_{DisjP}$ *Kemi tabi Adebimpe*] ***ni***   *o   ra   adirẹ naa*
             Q   Kemi or   Adebimpe FOC PRON buy cloth the
             "Did KEMI or ADEBIMPE buy the cloth"   (AltQ✓; PolQ#)

       b.   *Ṣe* [$_{DisjP}$ *Kemi tabi Adebimpe*] *ra   adirẹ naa*
             Q   Kemi or   Adebimpe buy adire the
             "Did Kemi or Adebime buy the cloth"   (AltQ#, PolQ✓)

(4)   a.   #*Ṣe ọmọ naa* [$_{DisjP}$ *ọkunrin tabi obinrin*]?
             Q child the   male   or   female
             Intended: "Is the child a boy or a girl?"

       b.   *Ṣe* [$_{DisjP}$ *ọkunrin tabi obinrin*] ***ni***   *ọmọ naa?*
             Q   male   or   female FOC child the
             "Is the child a boy or a girl?"

I assume that the surface word order in AltQs is derived via movement of the disjunction from its base position to the specifier of a designated focus phrase headed by the focus marker *ni*, as in (5-a), while the polar question reflects base word order, (5-b).[4]

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[3]Unless otherwise noted, all data are from fieldwork carried out by the author in Tübingen, London and Amherst. Examples are transcribed using standard Yoruba orthography. The following abbreviations are used in the glosses: FOC=focus particle, Q= interrogative particle, PRON=resumptive subject pronoun, NEG=negation NEG$_{FS}$=focus sensitive negation, REL=relative clause complementizer.

[4]An alternative syntactic derivation for Yoruba AltQs compatible with the data discussed so far, is as in (i). I will leave this possibility aside in what follows.

(i)   [$_{CP}$ *Ṣe* [$_{DisjP}$ [$_{FocP}$ Bata [$_{\overline{Foc'}}$ ~~ni Kemi ra~~]] tabi$_{Disj}$ [$_{FocP}$ Iwe [$_{Foc'}$ ni Kemi ra]]]]

(5) a. [$_{CP}$ Ṣe [$_{TP}$ *Kemi ra* [$_{DisjP}$ *bata tabi iwe*]]]   (PolQ)
     b. [$_{CP}$ Ṣe [$_{FocP}$ [$_{DisjP}$ *bata tabi iwe*]$_1$ [$_{Foc'}$ *ni*$_{Foc}$ [$_{TP}$ *Kemi ra t*$_1$]]]]   (AltQ)

Fronting of disjunction in AltQs closely resembles *wh-* and focus fronting in Yoruba, which have been argued to involve movement to the specifier of a focus phrase (Bisang & Sonaiya 2000, Aboh 2003). They are morphologically similar in that they all require the insertion of a particle, *ni*, after the fronted element and syntactically, they all exhibit similar locality restrictions. The examples below show, for example, that wh-movement (6-b) disjunction fronting (6-c) and focus fronting (6-d) are disallowed from within a relative clause.

(6) a. *Bolu gba obinrin ti   o   le so   Ede   Hausa si iṣe.*
         Bolu take woman REL PRON can speak language Hausa for job.
         "Bolu hired a woman who can speak Hausa."
     b. *Ede   wo   ni Bolu gba obinrin ti   o   le   so   si   iṣe.*
         Language which FOC Bolu hire woman REL PRON can speak for job
         Intended: "For which language x : Bolu hired a woman who can speak x."
     c. *Ṣe Ede Hausa tabi Ede Igbo ni   Bolu gba obinrin ti   o   le   so   si   iṣe.*
         Q lang. Hausa or   lang. Igbo FOC Bolu hire woman REL PRON can speak for job
         Intended: "For which of Hausa or Igbo: Bolue hired a woman who can speak x."
     d. *Ede   Hausa ni Bolu gba obinrin ti   o   le   so   si   iṣe.*
         language Hausa FOC Bolu hire woman REL PRON can speak for job
         Intended: "Bolu hired a woman who can speak HAUSA."

The Yoruba pattern is relatively rare crosslinguistically, although it has been reported in other unrelated languages, e.g. Yucatec Maya (AnderBois 2014). What is more common is for alternative questions to require focus marking of some kind, e.g. a pitch accent. We will spell out a compositional account for AltQ and PolQ interpretations that can shed some light on the one-to-one correspondence between focus fronting (or focus more generally) and AltQ interpretations, but first we present some data bearing on the presuppositions associated with AltQs.

2.2. Presuppositions of Alternative Questions

Two presuppositions, termed *exhaustivity presupposition* and the *mutual exclusivity presupposition* have been discussed in connection with alternative questions (Biezma & Rawlins 2012). The former restricts them to use in contexts where the two specified alternatives partition the common ground, ruling out *neither* as a felicitous answer, as in (7-a). The latter excludes contexts where both alternatives are true simultaneously, ruling out *both* as a felicitous answer, as in (7-b)

(7)   *Did Kemi by SHOES or a BOOK?*
        a.   ⤳ Kemi bought one of the two
        b.   ⤳ Kemi didn't buy both

The Yoruba facts are subtly different: While they seem to trigger the same mutual exclusivity pre-suppositions as English AltQs, native speaker judgements differed from English in contexts where the exhaustivity presupposition was not satisfied. Yoruba AltQs were judged infelicitous when they occurred in contexts leaving open the possibility that both alternatives were true, (8), confirming the mutual exclusivity presupposition[5]. But, unlike English, Yoruba alternative questions were accepted by speakers in context where it was compatible with the conversational participants' beliefs that neither alternative was true, e.g in (9) and (10).

(8)   CONTEXT: Bolu knows that both Segun and Tunji voted in the recent election, but he does not know who they voted for...

        # Bolu ko   mo   boya Segun tabi Tunji ni   o   dibo fun Buhari.
        Bolu   NEG know Q   Segun or   Tunji FOC PRON vote for Buhari.
        "Bolu doesn't know whether SEGUN or TUNJI voted for Buhari."

(9)   CONTEXT: Your family takes turns cooking dinner, but you've forgotten whose turn it is tonight. You know it's not your turn, but it could be your brother's, your mother's or your father's. You ask:

        Ṣe Tunji tabi Baba ni   o   maa ṣe   ounjẹ loni.
        Q Tunji or   father FOC PRON will cook food today
        'Will TUNJI or DAD cook dinner today?'

(10)   CONTEXT: Bolu comes home and finds a new adirẹ on the table. It could have been bought by one of his daughters, Kemi or Adebimpe, but it also might have been bought by his wife.

        Bolu ko   mo   boya Kemi tabi Adebimpe ni   o   ra   adirẹ.
        Bolu NEG know Q   Kemi or   Adebimpe FOC PRON buy adire
        'Bolu doesn't know whether KEMI or ADEBIMPE bought the adire.

A satisfactory analysis of disjunctive questions should provide an account of how the presup-position(s) associated with alternative questions arise and address the question of crosslinguistic variation in the nature of these presuppositions highlighted by the Yorbua data. We will return to this topic in section 4 and propose a modification of the alternative semantic account advocated in section 3 which can do so.

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[5]Note that the projective behavior of the mutual exclusivity inference, e.g. under *know*, is an indication that it is presupposed material.

3. The Compositional Interpretation of Alternative and Polar Questions

Following much previous work on the semantics of disjunctive questions (Beck & Kim 2006, Romero & Han 2003, Biezma & Rawlins 2012, and many others) we take the denotations of the polar and alternative disjunctive question in (1) to be the sets in (11-b) and (11-a) respectively.

(11)   a.   PolQ: $\{\lambda w.$ Kemi bought a book or the shoes in w, $\lambda w.$ Kemi didn't buy a book or the shoes in w$\}$
        b.   AltQ: $\{\lambda w.$ Kemi bought a book in w. $\lambda w.$ Kemi bought the shoes in w. $\}$

The goal in this section, then, is to provide a compositional semantics that will generate the set in (11-a) for (2-b) and the set in (11-b) for (2-a). We will consider two major approaches to this problem: The first, including early work by Larson (1985) as well as more recent proposals, for example by Nicolae (2013), derives the two different sets from variable scope of a quantificational disjunctive operator relative to a question particle under a Karttunen (1977)-style interrogative semantics. The second type of account, pursued for example by Beck & Kim (2006) and Erlewine (2014) relies on a disjunctive operator whose semantic contribution varies in alternative and polar questions. In AltQs, a disjunction operator that introduces alternatives is responsible for the generation of alternative question interpretations, while in PolQs the disjunction contributes an existential quantifier meaning. We'll look first at how a quantificational analysis could be applied to the Yoruba data, followed by a sketch of an alternative semantic account. Then Section 2.3 assesses the evidence for both analyses and argues in favour of an alternative semantic account based on data from intervention effects and focus-marking.

3.1. The Quantificational Analysis

A first approach to deriving the question sets of polar and alternative questions builds on a Karttunen semantics for questions where wh-pronouns contribute existential quantification and outscope a set forming Q-operator, (12-a).The structure and derivation of alternative questions under this approach is similar to that of wh-question with the existential quantification coming from the disjunctive operator, given in (12-b)[6].

(12)   a. $[\![Q]\!] = \lambda p_{\langle st \rangle}.\lambda q_{\langle st \rangle}.p = q$
        b. $[\![or]\!] = \lambda x.\lambda y.\lambda P_{\langle et \rangle}\exists z[(z = x \vee z = y) \wedge P(x)]$

The alternative question in (3-a) is associated with the LF in (13-a) and yields the denotation in (13-b), which is the desired set of propositions for an AltQ interpretation. Note however that the

[6]A slight modification of a Karttunen interrogative semantics is required in order to maintain a standard type $\langle\langle et \rangle t\rangle$ denotation for the existential quantifier. Here I follow Nicolae (2013) who credits lecture notes by Irene Heim.

final movement of the DisjP to a position higher than the Q must take place covertly. In the overt syntax the disjunction remains in the specifier of the FocP, between the interrogative particle *Ṣe* and the focus particle *ni*.

(13)   a. $[_{CP}$ 1 $[_{DisjP}$ Ade or Kemi] 2 $[_{C'}$ [Q $t_{st,1}$] [$\lambda w.$ $[_{FocP}$ $t_{e,2}$ 2 $[_{Foc'}$ ni $[_{TP}$ PRON$_{e,2}$ buy cloth w]]]]]]]

     b. $[\![(13\text{-}a)]\!] = \lambda p.\exists x[(x = Kemi \vee x = Adebimpe) \wedge p = \lambda w.buy(cloth, x, w)]$

To derive polar questions under this apporach, the disjunction contributes the same existential quantification, but unlike in alternative questions, it remains in a position within the scope of the Q-operator and thus does not affect the form of the resulting question set. This is spelled out below for the polar question in (3-b) which has the LF structure in (14-a) and derives the set in (14-b).

(14)   a. $[_{CP}$ Q $\lambda w.$ $[_{TP}$ $[_{DisjP}$ Kemi or Ade] buy cloth w]]
     b. $[\![(14\text{-}a)]\!] = \lambda p.p = \lambda w.\exists x[(x = K \vee x = A) \wedge buy(adire, x, w)]$

The set in (14-b) is a singleton set and a further step is required in order to obtain a two membered set. We leave it open how to derive the more standard two-membered polar question denotation, as there are a number of approaches on the market: The question denotation must be applied to a further operator, like the one used in Uegaki (2015), crediting George (2011) which partitions W based on the proposition(s) in the question set applied to it. Or, it must undergo coercion extra-compositionally , e.g via the coercion rule proposed by Biezma & Rawlins (2012) in (15) for singleton question denotations. A third, more standard option is to use a different Q-operator for polar questions, such as the one proposed in Hamblin (1973).

(15)   ANTI-SINGLETON COERCION (Biezma & Rawlins 2012, p. 33)
     If $|[\![\alpha]\!]| = 1$, where α is of type $\langle s, tt \rangle$ and denotes $\{A\}$, then α can be coerced (as a last resort) into the denotation $\{\lambda w.A(w), \lambda w.\neg A(w)\}$

Under the quantificational approach the difference between polar and alternative question interpretations arises as a scope ambiguity from the relative scope of disjunction and the interrogative operator: If the disjunction takes wide scope, an alternative question is generated while an LF where it takes narrow scope relative to Q will derive a polar question. On the face of it, this correlates well with the observation that disjunction must undergo fronting in alternative but not polar questions. However, this cannot be the end of the story, since the fronted disjunction remains below the Q-particle *Ṣe* at surface syntax, even when it is fronted. If a quantificational analysis is to be pursued, something more needs to be said about how the disjunction recieves wider scope than Q at LF in AltQs. There are a number of avenues which could be explored: It might be the case that the high DisjP can undergo further covert movement to a position higher than *Ṣe*. Another

possibility is that *Ṣe* is distinct from the (covert) Q operator, a plausible hypothesis in light of its absence in *wh*-questions. Whatever the final step in the argumentation, though, it needs to be available only for disjunction having undergone movement to FocP in order to explain the one-to-one correspondence observed between fronting and alternative question interpretations. We will come back to this point in the discussion in 3.3, but first we spell out the second analysis for disjunctive questions.

3.2. The Alternative Semantics Analysis

The second approach to disjunctive questions builds on an alternative semantics for questions, developed initially for wh-in-situ languages like Japanese (Shimoyama 2006, Kratzer & Shimoyama 2002) but which has also been pursued in *wh*-fronting languages (for example in Beck 2006). This approach derives question sets via a wh-pronoun, (16-a), that introduces alternatives, for example in a Roothian two-tiered framework, which compose with the rest of the material in the sentence via Hamblin Function Application, (16-c), until it forms a set of propositions which is taken as the question denotation by a Q-operator that triggers the meaning rule in (16-b)[7].

(16)   a. $[\![who]\!]^g_{Alt} = \{x : x \in D_e \ \& \ person(x)\}$

       b.   MEAINGING RULE Q
             For any node α such that $\alpha = [Q \ \beta]$, then $[\![\alpha]\!]^g_O = [\![\beta]\!]^g_{Alt}$

       c.   POINTWISE FUNCTION APPLICATION (Kratzer & Shimoyama 2002)
             If α is a branching node with daughters β and γ and $[\![\beta]\!]^g_{Alt} \subseteq D_\sigma$ and $[\![\gamma]\!]^g_{Alt} \subseteq D_{\langle\sigma,\tau\rangle}$,
             then $[\![\alpha]\!]^g_{Alt} = \{a \in D_\tau : \exists b \exists c [b \in [\![\beta]\!]^g_{Alt} \& c \in [\![\gamma]\!]^g_{Alt} \& a = c(b)]\}$

Beck & Kim (2006) extend the above alternative semantics for interrogatives to alternative questions by proposing that disjunction introduces alternatives on the roothian alternative semantic tier, specifically, the two-membered set containing each disjunct. This is done via something like the meaning rule in (17)[8]. This two membered set combines via pointwise FA with the rest of the material in the sentence to yield a set of two propositions which, when they combine with the Q-operator, become the alternative question denotation. This is illustrated below for the sentence in (3-a), which is assigned the LF in (18-a) and receives the denotation in (18-b).

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[7]Rules for Predicate Modification and Predicate Abstraction must also be modified for pairwise composition. There are questions about the validity of the rule for pairwise predicate abstraction. Kratzer & Shimoyama (2002) provide one version of a PA rule, but it is questionable whether this derives the right results (cf. Novel & Romero 2010). We will not address this issue here.

[8]This meaning rule is somewhat different from Beck & Kim's in that the ordinary semantic value of an focussed disjunction is undefined. We need this modification to account for the non-availablity of *PolQ* interpretations in cases of intervention by negation discussed in 3.3.

(17)   MEANING RULE FOR FOCUSSED DISJUNCTION:
        For any focussed node α such that $\alpha = [\beta \; or \; \gamma]_F$,
        $[\![\alpha]\!]^g_{Alt} = [\![\beta]\!]^g_{Alt} \cup [\![\gamma]\!]^g_{Alt}$
        and $[\![\alpha]\!]^g_O$ is undefined

(18)   a. $[_{CP}$ Ṣe $[\; \lambda w. \; [_{FP} \; [_{DisjP}$ Adebimpe tabi Kehinde $] \; 1 \; [_{F'}$ ni $[_{TP}$ o$_1$ $[_{VP}$ ra adire $]]]]]]$
        b. $[\![(18\text{-}a)]\!]^g_O = \{p : \exists x \in \{Adebimpe, Taiwo\} \; \& \; p = \lambda w.buy.adire(x, w)\}$

In polar questions, disjunction is taken to contribute the same existential quantifier as in the quantificational account above. None of the lexical items in the structure contribute a non-singleton on the alternative semantic tier, so the derivation proceeds just as in (14-a) and the resulting alternative semantic value of the sister to Q is the same singleton set derived by the quantificational account in (14-b). The Q-operator takes this set as the question denotation and then, as with the quantificational account, a further step or distinct Q operator is required to arrive at a two-membered polar question denotation.

Under this approach, the difference between the alternative question and polar question interpretation is the result of a lexical ambiguity: The focussed disjunction in the alternative questions triggers a meaning rule for disjunction which introduces alternatives, while an unfocused disjunction contributes its usual quantificational meaning leading to a polar question interpretation. There is some crosslinguistic evidence for an account based on lexical ambiguity, since many languages employ two morphologically distinct disjunction operators for alternative and polar questions (cf. Erlewine 2014 for Mandarin, Biezma & Rawlins 2015), however it's worth noting that in many of these languages one of them can often still generate both alternative and polar questions. This account also sheds some light relationship between focus fronting and alternative question interpretations, since focus marking of the disjunction, which triggers the meaning rule that generates AltQ interpretations, also causes it to move to the specifier of FocP.

3.3. Arguments for an Alternative Semantics

We have introduced two analyses to derive the interpretation of disjunctive questions which can both successfully derive the alternative and polar question sets. We suggested above that under an alternative semantics account the correlation between an alternative question meaning and focus fronting is explained by the requirement that the meaning rule for disjunction be triggered by focus and therefore occurs in only those environments where the disjunction has undergone focus fronting. Under the quantificational approach, on the other hand, we did not have a principled way of explaining the obligatoriness of focus fronting in the case of alternative questions, although we do not claim that it wouldn't be possible to develop such an explanation. In the next section, we look more closely at evidence that will help us choose between the two proposals. We argue that

the strongest evidence in favour of the alternative semantics account comes from the presence of intervention effects in alternative questions in Yoruba but begin by considering a second argument based on the distribution of alternative-introducing material in Yoruba.

3.3.1. The Argument from Focus

A first argument in favour of the alternative semantics account of AltQs in Yoruba comes from the distribution of material that generates alternatives in the language. Elements which have been claimed in the formal semantic literature to introduce alternatives, including wh-pronouns (Beck 2006) and foci (Rooth 1992) undergo the same fronting as disjunction in AltQs to a position at the left of the clause, followed by the particle *ni*. This is obligatory for wh-pronouns and the associates of focus sensitive particles such as the exclusive particle *nikan* and the focus sensitive negation *kọ*[9] and optional for answers to a QUD and contrastive foci. If the hypothesis that fronting marks constituents which introduce alternatives is correct, as the distributional evidence suggests, then the obligatory fronting of the disjunction in alternative questions provides a preliminary indication that an alternative semantic analysis of disjunction is on the right track.

(19) a. *Iwe   wo   **ni**   won ra?*
          Book which FOC 2.pl buy
          "Which book did you buy"   (wh-question)

(20) a. *Eja nikan **ni**   Bolu ra.*
          Fish only   FOC Bolu buy
          "Bolu only bought FISH" (# 'only BOLU boght fish.')
      b. **Bolu ra (nikan) Eja (nikan).*   (associate of *only*)

(21) a. *Adebimpe kọ   **ni**   o   fo   ferese.*
          Adebimpe NEG_{FS} FOC PRON break window.
          "It wasn't Adebimpe who broke the window."
      b. **Adebimpe kọ fo ferese.*   (associate of *kọ*)

(22) CONTEXT: Did you buy shoes?

      a. *Iwe   **ni**   mo ra.*
          Book FOC 1.sg buy.
          "I bought a BOOK."   (contrastive focus)

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[9]Yoruba has two different negation particles *ko* and *kọ* (/ko/ and /kɔ/). The first corresponds to ordinary negation while the second obligatorily co-occurs with focus fronting and yields an interpretation similar to a negated cleft.

3.3.2. The Argument from Intervention Effects

A stronger argument in favor of an alternative semantics for disjunction comes from intervention effects with alternative questions. Beck & Kim (2006) note that in many languages including English, German and Korean alternative question interpretations are blocked when a focus sensitive operator intervenes between the disjunction in an alternative question and the interrogative complementizer, as schematized in (23-b). They propose that that this is an instance of focus intervention, similar to the account of intervention in *wh*-questions proposed in Beck (2006). When a focus evaluating operator ($\sim$, diagnosed by the presence of a focus sensitive particle) is present at LF in a position between an alternative generating disjunction or wh-pronoun and the corresponding Q-operator, the alternatives they generate are evaluated by the focus evaluating $\sim$-operator. The meaning rule triggered by the $\sim$-operator, in (24), is defined in such a way that it resets the alternative semantic value of the node dominating it to the singleton set containing its ordinary semantic value. Depending on the way the meaning rule for disjunction is defined, this will either generate a singleton set corresponding to the polar question interpretation of the question, or will be undefined (as with our proposed meaning rule).

(23) a. Did only Sally$_F$ teach Syntax or Semantics?   (# AltQ, ✓PolQ)
      b. [Q ... [$\sim$ ... [[...]$_F$ [$_{DisjP}$ A or B]]]]

(24) Meaning Rule $\sim$:
      For any node α such that $\alpha = [\sim C\ \beta]$,
      $[\![\alpha]\!]^g_O$ is defined if and only if $g(C) \subseteq [\![\beta]\!]^g_{Alt}$, if so:
      $[\![\alpha]\!]^g_O = [\![\beta]\!]^g_O$ and $[\![\alpha]\!]^g_{Alt} = \{[\![\beta]\!]^g_O\}$

The possible interpretation(s) of configurations as in (23-b) can be used as evidence for or against an alternative semantics account, but in Yoruba they are difficult to test. The obligatory movement to Spec FocP in alternative questions would likely obviate intervention effects, as *wh*-fronting has been observed to do in other languages (Beck 1996, 2006). Negation, for example, is a crosslinguistically stable intervener, but in (25), where the disjunction has moved to a surface position higher than the negation, no intervention arises.

(25) *Ṣe Adebimpe tabi Taiwo ni   o   ko   fo   ferese*?
      Q Adebimpe or   Taiwo FOC PRON NEG break window
      "Was it Adebimple or Taiwo who didn't break the window?"

It is however possible to test for intervention in configurations where a focus sensitive operator targets the disjunction in an AltQ, as in (26) for which the alternative semantics account also predicts an intervention effect caused by the squiggle accompanying the focus sensitive operator.

(26) $[_{CP}$ Q [Op$_{FS}$ [$\sim$ [$[_{DisjP}$ A or B $]_F$ ...]]]]

This configuration does lead to intervention effects, as illustrated for the two reliably focus sensitive operators in Yoruba: the exclusive particle *nikan* and the focus sensitive negation *kọ*. With the exclusive particle *nikan*, this configuration yielded only a polar question interpretation, despite the fronting of the disjunction, as in (27). With the focus sensitive negation, on the other hand, it was rejected under any interpretation, (28).

(27)   Context: You know that only one of your two sisters Taiwo or Kehinde will go to Lagos, but you're not sure which of the two will go. You ask your mother:

        #*Ṣe Taiwo tabi Kehinde nikan ni   o   maa lọ si Eko*?
        Q Taiwo or   Kehinde only FOC PRON will go to Lagos
        Intended: "For which of Taiwo or Kehinde is it true that only they will go to Lagos?"
        (Consultant's Comment: "You want to confirm if only one of them will go.")

(28)   *Ṣe Adebimpe tabi Taiwo kọ   ni   o   fo   ferese?*
        Q   Adebimpe or   Taiwo NEG FOC PRON break window.
        Intended: "which of Adebimpe or Taiwo didn't break the window?"

The quantificational account of AltQs does not predict any effect of the presence of a focus sensitive operator on the generation of an alternative question interpretation, and the judgements reported in (27) and (28) are unexpected. The alternative-semantic account on the other hand offers an explanation of these facts. The $\sim$-operator, which must be in a position higher than the disjunction, but within the scope of Q, blocks the alternatives generated within the disjunction from being used by Q. One unexpected fact under this account is the contrast between intervention by focus sensitive negation, causing ungrammaticality, versus intervention by the exclusive particle, which generates an acceptable polar question interpretation. If the meaning rule for negation proposed in section 3.2 is required for any instances in which the disjunction is focussed then all cases of intervention should pattern like the focus sensitive negation, because the ordinary semantic value of the disjunction is undefined, so the alternative semantic value generated from the meaning rule for $\sim$ will be undefined as well, resulting in an undefined question denotation. If a quantificational disjunction can be used instead, then the polar question meaning is predicted to be available too, as with the exclusive particle. I leave an explanation of the differing behaviour of the exclusive particle and negation with respect to intervention for future work.

4. Deriving the Presuppositions of Alternative Questions

The previous section argued for a Hamblin semantics to derive the question set of alternative questions in Yoruba. Under the proposed analysis, focus marking of the disjunction played an important role in deriving the alternative question set by licensing the use of a meaning rule introducing al-

ternatives into the computation. The semantics proposed so far does not, however, explain the presence of the mutual exclusivity presupposition associated with Yoruba alternative questions. The relevant presupposition introduces the requirement that at least one of the alternatives in the question set be false, and is responsible for the infelicity of question below (repeated from 2.2):

(29)   CONTEXT: Bolu knows that both Segun and Tunji voted in the recent election, but he does not know who they voted for...

      # *Bolu ko   mo   boya Segun tabi Tunji ni   o   dibo fun Buhari.*
      Bolu   NEG know Q   Segun or   Tunji FOC PRON vote for Buhari.
      "Bolu doesn't know whether SEGUN or TUNJI voted for Buhari."

Notably, a second presupposition associated with AltQs in other languages, requiring that one of the alternatives be true is absent in Yoruba, as illutrated by the acceptability of the alternative question in the context below (repeated from 2.2).

(30)   CONTEXT: Your family takes turns cooking dinner, but you've forgotten whose turn it is tonight. You know it's not yours, but it could be your brother's, your mother's or your father's. You ask:

      Ṣe Tunji tabi Baba ni   o   maa ṣe   ounję loni.
      Q Tunji or   father FOC PRON will cook food today
      'Will TUNJI or DAD cook dinner today?'

In this section we put forward a proposal to account for the observed presuppositionality of AltQs in Yoruba. It locates the focus particle *ni* as the source of this presupposition, which we model as a homogeniety presupposition, inspired by the account of it-clefts in Büring & Križ (2013). This formalization has the advantage of predicting the mutual exclusivity requirement without requiring exhaustivity and as such is well suited to the Yoruba data. Our claim is supported by data from inferences present in cases of focus fronting beyond alternative questions. This account provides an interesting explanation for observed variation between English and Yoruba alternative questions with respect to their presuppositions: While focus marking is likely responsible for the generation of the alternative question set in both Yoruba and English (presumably by licensing the alternative-introducing meaning rule for disjunction), the precise nature of inferences introduced by focus-marking may vary crosslinguistically, leading to differences in the presuppositions triggered by alternative questions.

4.1. Deriving Mutual Exclusivity from the Homogeneity Presupposition

The account for the badness of a *both* answers to an alternative question draws heavily on the analysis of it-clefts proposed in Büring & Križ (2013). They argue that the exhaustivity inference

in it-clefts, which, in the example below is responsible for the inference that no one other than Nadine brought potato salad, is the result of a homogeneity presupposition introduced by the cleft. Technically, they spell this out via a null CLEFT-operator with the following denotation.

(31)   It was Nadine who brought potato salad.
         ⤳ Nobody else brought potato salad.

(32)   CLEFT $= \lambda z.\lambda P : \forall x \in Max(P)[z \not\sqsubset x].P(z)$[10]   (Büring & Križ 2013, p.9)

The presupposition introduced by the cleft will guarantee that either Nadine did not bring potato salad, or she is not a proper part of a plural individual who brought potato. Together with the assertion of the cleft (that Nadine brought potato salad) and the assumption that natural language predicates are closed under sum formation (Schwarzschild 1993, Champollion 2010), this delivers the exhaustivity presupposition, since if someone else brought potato salad, Nadine would be a proper part of the maximal individual who brought potato salad.

This presupposition can also deliver the mutual exclusivity inference that is associated with Yoruba alternative questions, when it is applied pairwise to each alternative. If Büring & Križ's CLEFT operator is applied to each disjunct of an AltQ, via pairwise function application, and each resulting function is then applied to the predicate created by movement of the disjunction it will deliver two homogeneity presuppositions: neither the first disjunct nor the second disjunct can be a proper part of the maximal plurality of which the predicated (created by fronting of the disjunction) is true. If the predicate were true of both alternatives in the disjunction, both would be proper parts of an element of Max(P), leading to presupposition failure if mutual exclusivity is not satisfied. This is illustrated below for an English clefted AltQ with the LF in (33-b), which is assigned the denotation in (33-c).The question set derived in this way does not introduce any requirement that one of the two alternatives, Sonja bringing a potato salad or Nadine bringing a potato salad, be true, as intended.

(33)   a.   Was it Nadine or Sonja who brought potato salad?
         b.   [Q λw[[CLEFT [$_{DisjP}$ Nadine or Sonja]] 1 [Brought potato salad t_1]]]
         c.   { $\lambda w.\forall x \in Max(\lambda y.y$ brought potato salad in w) [Sonja $\not\sqsubset$ x]: Sonja brought potato salad in w ; $\lambda w.\forall x \in Max(\lambda y.y$ brought potato salad in w) [Nadine $\not\sqsubset$ x]: Nadine brought potato salad in w }

---

[10]Where $\sqcup$ is the mereological sum operator (Link 1983) and:
X $\sqsubseteq$ Y ('X is a mereological part of X') iff $X \sqcup Y = Y$
X $\sqsubset$ Y ('X is a proper mereological part of Y') iff $X \sqsubseteq Y$ and not $Y \sqsubseteq X$
For any predicate P, Max(P) is the set of individuals x such that P(x) & $\neg\exists y[P(y)\&x \sqsubset y]$

4.2. Locating the Source of the Homogeneity Presupposition

A homogeneity presupposition can derive the mutual exclusivity presupposition, but how does this presupposition arise in Yoruba alternative questions? The focus marker *ni* is a good candidate, as its use elsewhere in the language seems to correlate with the generation of similar inferences. For example, the copular use of *ni* is also associated with an exhaustivity requirement, as noted by Bisang and Sonaiya (2000), who give the examples in (34) to illustrate the requirement that *ni* not be used as a copula with predicates that hold of multiple individuals. Similarly, focus fronting of a constituent to a pre-*ni* position also yields an exhaustivity inference, which projects from within questions, accounting for the unacceptability of the question in (35-a) in the second but not the first context. [11]

(34)   a.   *Ade ni   tisa.*
              Ade FOC teacher
              "Ade is a teacher."
        b.   *Ade ni   tisa   dara ju.*
              Ade FOC teacher good most
              "Ade is the best teacher."   (Bisang & Sonaiya 2000)

(35)   CONTEXT 1: Ade is talking to someone in his office. You can hear them talking and you
        want to know if he is talking to Kemi.
        CONTEXT 2: Ade is talking to multiple people throughout the day. You want to know if
        your friend Kemi is among them.
        a.   *Ṣe Kemi ni   Ade mba-soro?*
              Q Kemi FOC Ade talk-to
              'Is Ade talking to KEMI?'   (✓ Context 1, # Context 2)

The data from copular sentences and focus fronting support the hypothesis that *ni* is responsible for the homogeneity presupposition observed in alternative questions. Our proposed lexical entry for *ni*, in (36), is a version of Büring & Križ's CLEFT. The order of the arguments is reversed in this lexical entry to reflect the proposed syntax for alternative questions, in which *ni* is the head of a focus phrase whose specifier is filled by the fronted disjunction.

(36) $[\![\, ni \,]\!] = \lambda P \lambda z : \forall x \in Max(P)[z \not\sqsubseteq x].P(z)$

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[11]There are some exceptions to this generalization which remain a puzzle under this account of *ni*. For example, it is also obligatorily present in mention some *wh*-questions and, more worryingly, can mark the associate of an additive particle. We leave it to future work to determine under what conditions the exhaustivity requirement associated with *ni* can be supressed.

We assume that the focus particle combines first with the predicate formed by movement of disjunction out of the TP, and then with each disjunct via pairwise function application. The final proposal is spelled out for the example (3-a), associated with the LF in (37-b) in (38-e).

(37)   a.   *Ṣe* [$_{DisjP}$ *Kemi tabi Adebimpe*] ***ni***   *o*   *ra   adirẹ naa*
            Q   Kemi or   Adebimpe   FOC PRON buy cloth the
            "Did KEMI or ADEBIMPE buy the cloth"

       b.   [$_{CP}$ Ṣe [$_{FocP}$ 2 [$_{DisjP}$ Adebimpe tabi Kehinde] [$_{Foc'}$ ni [$_{TP}$ 1 o$_1$ [$_{VP}$ ra adire w$_2$]]]]]

(38)   a. $[\![\, \text{TP} \,]\!]_{Alt} = \{\lambda x.buy(x, adire, w_2)\}$

       b. $[\![\, \text{Foc'} \,]\!]_{Alt} = \{\lambda x'.\forall y \in Max(\lambda x.buy(x, adire, w_2))[x' \not\sqsubseteq y] : buy(x', adire, w_2)\}$

       c. $[\![\, \text{DisjP}]\!]_{Alt} = \{Adebimpe, Kemi\}$

       d. $[\![\, \text{Foc'} \,]\!]_{Alt}([\![\, \text{DisjP}]\!]_{Alt}) =$
            $\{f : \exists x[x \in \{A, K\}\&f \text{ defined iff } \forall y \in Max(\lambda x.buy(x, adire, w_2))[x \not\sqsubseteq y]\&f = buy(x, Adire, w_2)]\}$

       e. $[\![\, \text{FocP}]\!]_{Alt} = [\![\, \text{CP} \,]\!]_O =$
            $\{p : \exists x[x \in \{Kemi, Adebimpe\}\&p = \lambda w.\forall y \in Max(\lambda x'.buy(x', adire, w))[x \not\sqsubseteq y] : buy(x, adire, w)]\}$

The resulting question set, in (38-e) includes the same two propositions as before, but with the additional presuppositions that Kemi and Adebimpe both not be a proper part of a maximal individual of which $\lambda x.buy(x, adire, w)$ is true, which boils down to the mutual exclusivity requirement that both propositions not be true at the same time.

5. Conclusion

This paper developed a compositional account of disjunctive questions in Yoruba and argued on the bases of the distribution of alternative introducing constituents and intervention effects that a hamblin semantics for alternative questions was best suited to explain the one-to-one correspondence between focus fronting and an alternative question interpretation observed in Yoruba. The alternative semantic account furthermore provided the basis for an account of the mutual exclusivity presupposition triggered by alternative questions in Yoruba. The homogeneity presupposition-introducing CLEFT of Büring and Križ (2013), when applied pointwise to each disjunct in the two-membered alternative set, was shown to deliver the mutual exclusivity requirement of alternative questions. The proposed semantics did not generate the exhaustivity presupposition associated with alternative questions in English, which we demonstrated were absent in Yoruba AltQs. The contrast between English and Yoruba here raises an interesting question. The observation that focus marking is crucial for the derivation of an alternative question interpretation is crosslinguistically stable (whether focus is marked syntactically, as in Yoruba, or intonationally, as in English). This fits well with the alternative semantic story we advocate here. Plausibly, variation arises as a result of subtle differences in the semantic contribution of focus marking in different languages.

While Yoruba employs a strategy for focus marking which closely resembles English it-cleft constructions, the semantic contribution of English intonational focus marking is different, resulting in the varying presuppositions observed in Yoruba and English.

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Exhaustification, *but*-Exceptives, and *Any*[1]

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Abstract. This paper proposes an exhaustification-based approach to the limited distribution of the *but*-exceptive á la Chierchia (2006, 2013) and shows that there is a total analogy between the weak NPI *any* and the *but*-exceptive. The core of the proposal is that just like *any*, *but* triggers a set of alternatives that is built on the subsets of the domain of quantification.

Keywords: exceptives, exhaustification, NPIs, domain alernative.

1. Introduction

In this paper, I intend to show that the limited distribution of the *but*-exceptive, within the exhaustification-based approach á la Chierchia (2006, 2013) and others, may be captured with exactly the same mechanism that captures that of NPIs. To the extent that this attempt is on the right track, it may be seen as an improvement of Gajewski's (2013) exhaustification-based analysis of the *but*-exceptive and provides further support for his claim that the license of the *but*-exceptive may be seen as an instance of NPI licensing.

Some terminologies used in the following discussion are introduced: the term 'host' refers to the determiner that heads the nominal projection that the *but*-exceptive is attached to (e.g, *every* in (1b)); 'associate' (e.g., *student* in (1b)) refers to the common noun (or noun phrase) which together with the *but*-exceptive semantically serves as the 'restriction' of the head determiner ; the term 'exception set' is reserved for the denotation of the complement of *but*. Here I simply assume that there exists some shifting operation that turns the complement of *but* set-denoting.

(1) a.

    b. Every student but Mary smokes.

1.1. The distribution of the *but*-exceptive

Intuitively, a *but*-exceptive serves to subtract some elements out of a set so that quantification over this set may hold. For instance, (2a/3a) says that the quantification in question over the set of students with respect to the property of smoking may hold if Mary is excluded (see (2b) and (3b)); crucially, both examples are true only if Mary is a student and she bears a different value from other students with respect to the property of smoking.

(2)   a. Every student *but Mary* smokes.

       b. Mary is a student,
          Mary does not smoke, and
          Every student who is not Mary smokes.

(3)   a. No student *but Mary* smokes.

       b. Mary is not a student,
          Mary smokes, and
          none of the students that are not Mary smoke.

There however seems to be more in the semantic components of *but* than just being a *minus* sign. As observed in many research (von Fintel 1993; Moltmann 1995; Lappin 1996; and others), not all quantificational determiners may host a *but*-exceptive (see (4)); the consensus from these literature is that only universals (e.g., *every*, *all*) and negative universals (e.g., *no*) may host a *but*-exceptive.[2]

(4)   <u>All/No/*Most/*Some/*Few/*At most 2/*Fewer than 2</u> students *but Mary* smokes.

Any hosts a *but*-exceptive in both its NPI and FCI incarnations, as shown in (5)-(6). Note however that not all environments where *any* is licensed are hospitable to *any…but…*; in the so called Strawson Downward-Entailing (henceforth, SDE) environments (see (7); see von Fintel (1999)), *any*, but not *any…but…*, is licensed.

(5)   Chris didn't see <u>any</u> student (*but Mary*).

(6)   Bill may pick <u>any</u> flavor of ice cream (*but toffee*).

(7)   a. Only Alan talked to <u>any</u> students (*but Mary).

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[2]Other exceptive markers such as *except* seem to have a freer distribution than *but*; several examples that involve the occurrence of *except* hosted by *some* have been reported in Peters and Westerståhl (2006) and García-Álvarez (2008). Nevertheless, as far as I am aware of, the consensus in the literature is that the *but*-exceptive can only occur with quantifiers that carry a universal or negative universal quantificational force.

    b. Chris is surprised/sorry that Alan talked to <u>any</u> students (*but Mary).

    c. The most senior faculty who talked to <u>any</u> students (*but Mary) got promoted.

1.2. The *Leastness* of the exception set

Most research on the exceptives have been centered on the co-occurrence restriction on the *but*-exceptive (Hoeksema 1987, 1996; von Fintel 1993; Moltmann 1995; Lappin 1996; Gajewski 2008, 2013; a.o.). Among them[3], von Fintel (1993) suggests that the co-occurrence restriction may be captured if it is assumed that *but* imposes a requirement of uniqueness and minimality on the exception set; the exception set should be the unique minimal one that makes the quantification in question true (see (8)).

(8) $[\![$ $[[$ D N *but* DP $]$ VP $]$ $]\!]=1$ iff:
      a. $[\![$ D $]\!]([\![$ N $]\!]$-$\{[\![$ DP $]\!]\})([\![$ VP $]\!]$), and
      b. for all S such that $[\![$ D $]\!]([\![$ N $]\!]$-S$)([\![$ VP $]\!]$), $\{[\![$ DP $]\!]\}\subseteq$S

Left Downward-Entailing (henceforth, LDE) quantifiers like *every* and *no* guarantee the uniqueness and the minimality of the exception set; for instance, if Mary is a student and all students other than Mary smoke, then the singleton set containing Mary is the unique minimal set that renders universal quantification true with respect to the property of smoking. On the other hand, the leastness cannot be guaranteed by a non-LDE quantifier like *some*; if some student who is not Mary smokes, then existential quantification is still true without Mary being excluded. The failure to satisfy the leastness requirement with *some* results in contradiction in the truth conditions of *some student but Mary smokes*; hence, the presence of a *but*-exceptive with *some* is ungrammatical.

von Fintel's (1993) analysis, however, as pointed out by Gajewski (2008), makes the wrong prediction in the case of the NPI *any*. The NPI *any* hosts a *but*-exceptive; nevertheless, there exists abundant evidence (e.g., Ladusaw 1979; Carlson 1980; a.o.) that suggests that *any* in its NPI incarnation carries an existential quantificational force. To solve this problem, Gajewski (2008) suggests that the *leastness* should be severed from the lexical meaning of *but*: *but* simply serves to subtract elements in the exception set from the domain of quantification, and *leastness* is guaranteed by a sentential operator LEAST. Gajewski's (2008) idea is sketched as in (9); the reader are referred to Gajewski (2008, 2013) for technical details.

(9)   a. LF of (5): $[_①$ LEAST $[_②$ NEG $[$ *any student but Mary* $[1[$ Chris saw t_1 $]]]]]$
      b. $[\![$ *but* $]\!]=\lambda X_{<e, t>}.\ \lambda Y_{<e, t>}.\ \text{Y-X}$

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[3]Due to the space limit, reviews and comparison of these proposals are out of the scope of this paper.

    c. $[\![$ ② $]\!]$ =1 iff ({x: Chris saw x}∩({y: y is a student}-{Mary})=∅;
        $[\![$ ① $]\!]$ =1 iff:
        i) ({x: Chris saw x}∩({y: y is a student}-{Mary}))=∅, and
        ii) ∀S[{x: Chris saw x}∩({y: y is a student}-S)=∅ →{Mary}⊆S]

1.3. The perspective and the roadmap

As Gajewski (2008, 2013) points out, LEAST should be seen as a pragmatic strengthening operator, just as the exhaustivity operator in Chierchia (2006), Chierchia et al. (2012) and others. Hence, it would be desirable if *leastness* with the *but*-exceptive can be subsumed under the phenomena that have received explanation within the exhaustification-based approach. An account that aims to achieve this goal is proposed by Gajewski (2013), based on which he further suggests that an analogy can be drawn between the *but*-exceptive and NPIs. In this account, *but* triggers a set of highly-structured alternatives which recursive application of exhaustification operates on. Empirically adequate as it is, this postulation however drives *but*-exceptive apart from NPIs and hence renders the connection between these two less clear than it is intended to be.

Building on von Fintel's (1993) and Gajewski's (2008; 2013) insight, I intend in this paper to show that within the exhaustification-based approach, there is indeed a total analogy between between NPIs and the *but*-exceptive. Specifically, I would like to suggest that the distribution of the *but*-exceptive may be captured by exactly the same mechanism that captures that of NPIs such as *any* in Chierchia (2006, 2013). Along with the previous wisdom, the only additional assumption needed to achieve this goal is that just like *any*, *but* triggers an alternative set that looks into the 'domain alternatives', namely, the subsets of the domain of quantification. To the extent that the proposal is on the right track, it may be seen as an improvement of Gajewski's (2013) analysis and lends further support to his claim that The *but*-exceptive may be seen as an NPI of some kind.

The rest of the discussion is structured as follows. To make this paper self-sufficient, I review Chierchia's (2006; 2013) account of NPIs in Section 2. The proposal is laid out in Section 3. Section 4 discusses how in addition to *every*, *no*, and *some*, the proposal may be extended to cases that involve structurally more complicated quantifiers. The conclusion is in Section 6.

2. Exhaustification and the Distribution of NPI *Any*

One widely received wisdom on the limited distribution of NPIs such as *any* and *ever*, which may be traced back to Fauconnier (1975a, b), Ladusaw (1979), von Fintel (1999) and others, is that these items are only grammatical in enviomnments that support a downward-entailing inference (an inference from a set to its subset) of some sort. Along with such an entailment-based approach to NPI licensing, Chierchia (2006, 2013), building on Krifka's (1995) idea, suggests an alternative-

based semantics to cash out the DE constraint on the distrubution of these items.

In Chierchia's (2013) system, The NPI *any* is an existential quantifier *per se*; in addition to its quantificational force, *any* triggers a set of domain alternatives, i.e., alternatives that are built on the subsets D′ of the quantificational domain D of *any*. In a toy model in which D contains only three students John, Bill and Mary, the set of subdomains based on which the alternatives triggered by *any* are built is just like what is illustrated in (11).

(10)   a. $\llbracket any_D \rrbracket = \lambda P_{<e, t>}.\ \lambda Q_{<e, t>}.\ \exists x \in D[P(x) \text{ and } Q(x)]$
        b. ALT(any_D)=$\{\lambda P_{<e, t>}.\ \lambda Q_{<e, t>}.\ \exists x \in D'[P(x) \text{ and } Q(x)]: D' \subseteq D\}$

(11)   D=$\{J, B, M\}$; $\{D': D' \subseteq D\}$=$\left\{ \begin{array}{c} \{J, B, M\} \\ \{J, B\}, \{J, M\}, \{B, M\} \\ \{J\}, \{B\}, \{M\} \\ \varnothing \end{array} \right\}$

An operator EXH, whose semantic contribution is similar to that of *only*, then operates on this set of alternatives; this operator serves to exclude all the alternatives that are not entailed by its prejacent (i.e., the proposition expressed by its sister at LF).

(12) $\llbracket \text{EXH} \rrbracket^w = \lambda p_{<s, t>}.\ p(w) \text{ and } \forall q[q \in \text{ALT}(p) \text{ and } q(w) \to p \subseteq q]$

Whether a polarity item like *any* can be licensed depends on whether the result of exhaustification gives consistent truth conditions. Consider (13a), where *any* is ungrammatical. The prejacent of EXH says that there is a student x in D such that Chris saw x; after exhaustification, the derived truth conditions further say that in none of the proper subdomains of D did Chris see a student. These truth conditions however are contradiction, for if Chris saw some student in D, there must be some subdomain D′ of D that contains some student that Chris saw. Given that exhaustification does not give consistent truth conditions, (13a) is ungrammatical. In the following, S_w stands for the extension of *student* in the world of evaluation w.

(13)   a. * Chris saw *any* student.
        b. LF of (13a): [EXH [any_D *student* [1 [*Chris saw* t_1]]]]
        c. $\exists x \in D[x \in S_w \text{ and Chris saw } x]$, and $\forall D'[\exists x \in D'[x \in S_w \text{ and Chris saw } x] \to D \subseteq D']$

Any is grammatical in the scope of a downward-entailing operator like negation. In this case, appending the operator EXH above the DE operator whose scope contains *any* gives consistent truth conditions. In (14a), the prejacent of EXH entails all the other alternatives; if there is no student in D that Chris saw, then in none of the subdomains D′ of D did Chris see any students. Given that exhaustification does not lead to contradiction, *any* is licensed in (14a)

(14)   a. Chris didn't see *any* students.

       b. LF of (14a): [EXH [NEG [*any*$_D$ *student* [1 [*Chris saw* t$_1$]]]]]]

       c. $\neg\exists x \in D[x \in S_w$ and Chris saw x]

3. Exhaustification and the *but*-Exceptive

The wisdom we have learned from von Fintel and Gajewski is that i) the complement of *but* should denote the unique minimal exception set that makes the quantification in question established, and ii) the *leastness* of the exception set should not be encoded in the lexical meaning of *but*. In the following, I would like to show how the mechanism sketched above that captures the distribution of NPIs can be extended to that of the *but*-exceptive.

3.1. *but* and domain alternatives

Along with Moltmann (1995), Lappin (1996), and Gajewski (2008, 2013), I assume that the exceptive phrase together with the restrictor N forms a constituent (see (15)).

(15)

$$
\begin{array}{c}
\text{DP} \\
\diagup \diagdown \\
\text{D} \quad \text{NP} \\
\diagup \diagdown \\
\text{N} \quad \text{EP} \\
\diagup \diagdown \\
\textit{but} \quad \text{DP}
\end{array}
$$

but subtracts the exception set from the intersection of the quantificational domain D and the extension of N. Just like *any*, the alternative set triggered by *but* sees the subdomains of the doamin of quantification D; it triggers a set of alternatives that are built on the subsets of D and the subsets of the exception set.

(16)   a. ⟦ *but*$_D$ ⟧ = $\lambda P_{<e,\,t>}.\ \lambda Q_{<e,\,t>}: P \subseteq D \cap Q.\ D \cap Q - P$

      b. ALT(*but*$_D$) = $\{[\lambda P'_{<e,\,t>}.\lambda Q_{<e,\,t>}.\ D' \cap Q - P']: D' \subseteq D$ and $P' \subseteq P\ \}$

And just like *any* and other polarity items, the presence of a *but*-exceptive requires the presence of the operator EXH; EXH operates on the alternative set triggered by *but* and excludes all the alternatives that are not entailed by its prejacent. Assuming our toy model, where D contains only three students John, Bill, and Mary, the alternative set triggered by *but* for the noun phrase *student*

but Mary is illustrated as in (17); the NP *student but Mary* denotes the alternative in the square.[4]

$$(17) \quad \text{ALT}(\textit{student but}_\text{D} \textit{ Mary}) = \left\{ \begin{array}{c} \{J, B, M\} - \varnothing, \boxed{\{J, B, M\}\text{-}\{M\}} \\ \{J, B\} - \varnothing, \{J, M\} - \varnothing, \{B, M\} - \varnothing \\ \{J, M\} - \{M\}, \{B, M\} - \{M\} \\ \{J\} - \varnothing, \{B\} - \varnothing, \{M\} - \varnothing, \{M\} - \{M\} \end{array} \right\}$$

Interestingly, after simplification, (17) looks exactly like (11), the set of subdomains based on which the alternative set triggered by *any*. The difference between the case of the NPI *any* and that of the *but*-exceptive is that in the case of *any* quantification operates on D, the maximal element in this set, whereas in the case of the *but*-exceptive, quantification operates on the difference of D and the exception set (as indicated by the square in (18)).

$$(18) \quad (17) = \left\{ \begin{array}{c} \{J, B, M\} \\ \boxed{\{J, B\}}, \{J, M\}, \{B, M\} \\ \{J\}, \{B\}, \{M\}, \\ \varnothing \end{array} \right\}$$

3.2. *every/no* vs. *some*

Every and *no* host a *but*-exceptive; intuitively, the quantificatioan in question holds only if the exception set (in (19a) and (21a), the singleton set that contains Mary) is excluded from the associate (in (19a) and (21a), the extension of *student*). With the lexical meaning of *but* and the assumptions on domain exhaustification laid out above, the LF and the truth conditions of (19a) are represented in (19b) and (19c).

(19)   a.   Every student *but Mary* smokes.

             b.   LF of (19a): [EXH [[*every* [*student* [*but*$_\text{D}$ *Mary*]]] smokes]]

             c. $\forall x[x \in (S_w \cap D\text{-}\{M\}) \rightarrow x$ smokes] and
                $\forall D' \subseteq D \forall P' \subseteq \{M\}[\forall x[x \in (S_w \cap D'\text{-}P') \rightarrow x$ smokes] $\rightarrow$
                                    $(D' \cap S_w\text{-}P') \subseteq (D \cap S_w\text{-}\{M\})$]

With the toy model assumed above, where John, Bill and Mary are the only students, the prejacent in (19b) asserts that all the students who are not Mary, namely John and Bill, smoke. As illustrated

---

[4]Strictly speaking, (17) should include alternatives such as $\{J, B\}\text{-}\{M\}$, those alternatives that are formed by the difference of some subset D' of D and some subset P' of the exception set P such that D' and P' do not overlap. Nevertheless, for such alternatives, there is always another one that is formed by the diffeece of some $D'' \subseteq D$ and some $P'' \subseteq P$ such that $P'' \subseteq D''$; for instance, $\{J, B\}\text{-}\{M\}$ is equivalent to $\{J, B, M \}\text{-}\{M\}$. Therefore, for simplicity, I ignore such alternatives in the illustration.

in (20), since *every* is LDE, exhaustification over the domain alternatives triggered by *but* excludes all the alternatives that are not a subset of {J, B} and hence excludes as well those that contain Mary (as indicated by ~~strikethrough~~). Given that the prejacent entails all the other alternatives that are not excluded, exhaustification in (19a) yields a consistent result. Hence, a *but*-exceptive is grammatical with *every*.

$$
(20) \quad \left\{ \begin{array}{c} \cancel{\{J, B, M\}} \\ \boxed{\{J, B\}}, \cancel{\{J, M\}}, \cancel{\{B, M\}} \\ \{J\}, \{B\}, \cancel{\{M\}}, \\ \varnothing \end{array} \right\}
$$

The co-occurrence of the negative universal *no* and the *but*-exceptive may be captured in the same way. Along with the assumptions above, the LF and the truth conditions of (21a) may be represented as in (21b) and (21c). With the toy model given above, these truth conditions may be illustrated with (20) as well: the prejacent in (21b) asserts that neither John nor Bill smokes, and exhaustification excludes all the alternatives that contains Mary. Just like *every*, *no* is LDE, given that all the alternatives not excluded are entailed by the prejacent, exhaustification yields a consistent result. Hence, the *but*-exceptive is grammatical with *no*.

(21) a. No student *but Mary* smokes.

b. LF of (21a): [EXH [[*no* [*student* [*but*$_D$ *Mary*]]] smokes]]

c. $\neg\exists x[x \in (S_w \cap D\text{-}\{M\})$ and x smokes], and
$\forall D' \subseteq D \forall P' \subseteq \{M\}[\neg\exists x[x \in (S_w \cap D'\text{-}P')$ and x smokes] $\rightarrow$
$(D' \cap S_w\text{-}P') \subseteq (D \cap S_w\text{-}\{M\})]$

The existential quantifier *some* does not host a *but*-exceptive (see (22a)). With the assumptions laid out above, the LF and the derived truth conditions of (22a) may be represented as in (22b) and (22c).

(22) a. *Some student *but Mary* smokes.

b. LF of (22a): [EXH [[*some* [*student* [*but*$_D$ *Mary*]]] smokes]]

c. $\exists x[x \in (S_w \cap D\text{-}\{M\})$ and x smokes], and
$\forall D' \subseteq D \forall P' \subseteq \{M\}[\exists x[x \in (S_w \cap D'\text{-}P')$ and x smokes] $\rightarrow$
$(S_w \cap D\text{-}\{M\}) \subseteq (S_w \cap D'\text{-}P')]$

The derived truth conditions of (22a), however, are contradiction for exactly the same reason why those of (13a) (see (13b)) are. With the toy example assumed above, the truth conditions (22c) may be illustrated as in (23): the prejacent in (22b) asserts that there is some student who is not Mary, namely John or Bill, smokes. Since *some*, unlike *every* and *no*, is left upward-entailing, all

alternatives that are not a superset of the set containing John and Bill are excluded after exhaustification. Nevertheless, excluding all these alternatives leads to contradiction, for if John or Bill smokes, then either the singleton set that contains John or the one that contains Bill may make the existnential quantification true. The *but*-exceptive hence is ungrammatical with *some*.

$$(23) \quad \left\{ \begin{array}{c} \{J, B, M\} \\ \boxed{\{J, B\}}, \cancel{\{J, M\}}, \cancel{\{B, M\}} \\ \cancel{\{J\}}, \cancel{\{B\}}, \cancel{\{M\}}, \\ \varnothing \end{array} \right\}$$

4. More Complicated Cases

4.1. *Exactly n*

Exactly n NP is non-monotonic and does not host a *but*-exceptive. Intuitively, *exactly two students smoke* says that two students smoke and no more than two students smoke. In various proposals (Landman 1998; Krifka 1999; Kennedy 2013; a.o.), the negative implication of an *exactly n NP* has been seen as a product of some pragmatic mechanism; the particle *exactly* is taken to be a signal of the obligatory application of such an mechanism. Landman (1998) suggests that semantically *exactly n NP* means the same as *n NP* but comes with an additional requirement that it be strengthened by an implicature-generating mechanism; Kennedy (2013) on the other hand suggests that *exactly* in *exactly n NP* may be seen as a 'slack regulator'. For the purpose of this paper, I will simply assume the semantics in (24) for *exactly n NP*, though this semantics may be implemented with any of the proposals mentioned in these references.

(24) $[\![$ *exactly n N VP* $]\!] = 1$ iff $| [\![N]\!] \cap [\![VP]\!] | = n$

With the assumptions laid out above, now consider (25a) and its LF. Assuming the toy model in which D contains only three students John, Mary and Bill, the prejacent of EXH in (25a) asserts that either John or Bill, but not both, smokes. *but* triggers a set of domain alternatives; given that *exactly n* is non-monotonic (e.g., that exactly one of John, Mary and Bill smokes neither entails nor is entailed by that exactly one of John and Bill smokes), all the domian alternatives that are not the prejacent are excluded.[5] The result of exhaustification is illustrated in (26).

(25)   a.   * Exactly one student *but Mary* smokes.
        b.   LF: [EXH [*exactly 1* [*student* [*but*_D *Mary*]] *smokes*]]

---

[5]The domain alternative $\varnothing$ need not be excluded, since this alternative cannot render the relevant quantification true.

(26)
$$\left\{ \begin{array}{c} \{J, B, M\} \\ \boxed{\{J, B\}}, \{J, M\}, \{B, M\} \\ \{J\}, \{B\}, \{M\}, \\ \varnothing \end{array} \right\}$$

Exhaustification in (26), however, results in contradiction: if the prejacent, namely that exactly one of John and Bill smokes, is true, then either {J} or {B} renders quantification by *exactly one* true; nevertheless, these two domain alternatives are excluded after exhaustification. Hence, the *but*-EP is ungrammatical in (26).

The above account for the incompatibility between the *but*-exceptive and *exactly n*, however, seems to encounter challenges in a scenario in which the set of students in the context of utterance is equivalent to the union of the exception set and the set of students that smoke; for instance, a scenarion in which with our toy model, both John and Bill are students that smoke. In such a scenario, exhaustification in (27a) gives the result in (27b): all the domain alternatives other than {J, B} that have more than one members are excluded; those that have only one member (or none) need not be excluded since they do not make quantification by *exactly two* true.

(27) a. * Exactly two students *but Mary* smoke.

  b.
$$\left\{ \begin{array}{c} \{J, B, M\} \\ \boxed{\{J, B\}}, \{J, M\}, \{B, M\} \\ \{J\}, \{B\}, \{M\}, \\ \varnothing \end{array} \right\}$$

At first glance, there seems no offending exclusion in (27b), and hence we may wrongly predict that the *but*-EP is grammatical in (27a). A closer look, neverhteless, suggests that the analysis laid out above is still on the right track: the prejacent in (27a) says that John and Bill are all and the only students that smoke; after exahsutification, the derived truth conditions further say that: (i) it is not the case that exactly two of John, Bill and Mary smoke, (ii) it is not the case that exactly two of John and Mary smoke, and iii) it is not the case that exactly two of Bill and Mary smoke. The prejacent together with (i) entails that Mary smokes. This however contradicts (ii) as well as (iii): if Mary smokes in this context of utterance, both (ii) and (iii) should be false. The proposed analysis then correctly predicts that even in such a special case, the *but*-EP with *exactly n* still cannot be licensed.

Intrim summary: the proposal, without relying on any further stipulations, correctly predicts that the *but*-EP is incompatible with *exactly n* across the board; in the case of *exatly n … but …*, there is always some domain alternative the exclusion of which leads to contradiction in the truth conditions.

4.2. *Fewer than n* and *At most n*

fewer than n and *at most n* are LDE; for instance, *fewer than two students smoke* entails that *fewer than two linguistics students smoke*, and *at most one student smokes* entails that *at most one linguistics student smokes*. Nevertheless, unlike the LDE quantifiers *every* and *no*, they do not host a *but*-EP (see (28)).

(28)   a.   * Fewer than two students *but Mary* smoke.
       b.   * At most one student *but Mary* smokes

These two modified numeral expressions have received great attention in the literature (Hackl 2000; Nouwen 2010; Schwarz et al. 2012; Kennedy 2013, 2015; and others). One idea that has been suggested (Hackl 2000; Schwarz et al. 2012; Kennedy 2015) is that the meaning of these expressions encodes maximality and inferiority (see (29)); for instance, *fewer than two students smoke* is true iff the maximal number of students who smoke is smaller than 2; *at most one student smokes* is true iff the maximal number of students who smoke is smaller than or equal to 1.

(29)   a. $[\![$ *fewer than n N VP* $]\!]$=1 iff $max(\{n' : |\, [\![N]\!] \cap [\![VP]\!]\, | \geq n'\}) < n$
       b. $[\![$ *at most n N VP* $]\!]$=1 iff $max(\{n' : |[\![N]\!] \cap [\![VP]\!]| \geq n'\}) \leq n$
       (for any set of numbers N′, $max(\text{N}') = \iota n[n \in \text{N}'$ and for all n′ such that n′$\in$N′, n′$\geq$n])

With these assumptions, one may assign (30a) the LF in (30b). After exhaustification over the domain alternatives triggered by *but*, the truth conditions in (30c) are derived.

(30)   a.   * Fewer than two students *but Mary* smoke.
       b.   LF of (30a): [EXH [[*fewer than two* [*students but$_D$ Mary*]] *smoke*]
       c. $max(\{$n: n of $\{$J, B$\}$ smokes $\})$<2, and
            for all X such that X$\not\subseteq$$\{J, B\}$, $max(\{$n: n of X smokes $\})$$\geq$2

Given that *fewer than n* is LDE, with our toy model, all the domain altrnatives that are subsets of $\{$J, B$\}$ are excluded (see (31)). The result of exhaustification, however, is contradiction: the truth conditions in (30c) (see also (31)) say that the maxinmal of number of n such that n of $\{$M$\}$ smokes is greater than or equal to 2, and this can never be true. The *but*-exceptive is therefore ungrammatical in (30a).

(31) $\left\{ \begin{array}{c} \text{\sout{\{J, B, M\}}} \\ \boxed{\{J, B\}}, \text{\sout{\{J, M\}}}, \text{\sout{\{B, M\}}} \\ \text{\sout{\{J\}}}, \text{\sout{\{B\}}}, \text{\sout{\{M\}}}, \\ \varnothing \end{array} \right\}$

The incompatibility of the *but*-exceptive with *at most n* is accounted for in the same way. With the LF in (32b), the truth conditions in (32c) are derived. These truth conditions are contradiction, however, for the same reason why those in (30c) are: after exhaustification over the domain alternaives, (32c) says that the maxinmal number of n such that n of {M} smokes is greater than 2, and this can never be true. The *but*-exceptive is thus ungrammatical in (32a).

(32)   a.   * At most one student *but Mary* smokes.

         b.   LF of (32a): [EXH [[*at most one* [*student but$_D$ Mary*]] *smokes*]

         c.   *max*({n: n of {J, B} smokes })≤1, and
            for all X such that X⊈{J, B}, *max*({n: n of X smokes })>1

4.3. Issues with *NULL*

The account proposed above for the incompatibility between the *but*-exceptive and the modified numeral expressions encounters challenges when it comes to 'zero': *exactly zero*, *fewer than one*, *at most zero* are ostensibly equivalent to *no*, and the proposal laid out above, without further implementation, predicts that the *but*-EP is grammatical with these expressions. (33) shows that this prediction is not borne out.

(33)   a.   * <u>Fewer than one</u> student *but Mary* smokes.

         b.   * <u>Exactly zero</u> students *but Mary* smoke.

         c.   * <u>At most zero</u> students *but Mary* smoke.

It is worth to point out that these expressions differ from *no* not only in hosting the *but*-EP; as pointed out in Gajewski (2011), these expressions, unlike *no*, fail to license strong NPIs such as *in days/weeks/years*.

(34)   a.   * <u>Exactly zero</u> students have visited me *in years*.

         b.   * <u>Fewer than one</u> student has visited me *in years*.

         c.   * <u>At most zero</u> students have visited me *in years*

No and *zero*, as already pointed out in several research, seemingly differ semantically in nature.

(35)   a.   No/*Zero students like SEMANTICS, either.   (Gajewski 2011)

         b.   No/*Zero occasion(s) did he mention my help.   (Deprez 1999)

         c.   She drank no/*zero martinis, not even weak ones.   (Postal 2004)

The facts in (34) and (35) suggest that an account for (33) requires a better understandng of 'zero'. Gajewski (2011) suggests that the facts in (34) and (35) may be explained if it is assumed that the grammar merely sees *zero* as just like another number and hence treats an expression like *exactly zero* just as *exactly 64*. It might be interesting to see how my proposal may be implemented with this idea to account for (33), though this has to be left for future study.

5. The *but*-exceptive and *any*

The NPI *any* hosts the *but*-EP, as shown in (5). The discussion above already suggests that there is a total analogy between the NPI *any* and the *but*-exceptive: both trigger an alternative set built on the subdomains of the domain of quantification. Under the proposal laid out above, licensing the NPI *any* in *any…but …* is simply a by-product of licensing the *but*-EP. With the composition rules in (36) and the LF in (37a), the truth conditions in (37c) are derived for (5). Given that exhaustification gives a consistent result, the *but*-EP, as well as the NPI *any*, is licensed in (5).

(5)   Chris didn't see <u>any</u> students (*but Mary*).

(36)   a. *Standard definition of application for* ALT *function*:
           $[\![\,\alpha\,]\!]^{ALT}=[\![\,\beta\,]\!]^{ALT}([\![\,\gamma\,]\!]^{ALT})$

      b. *Set tolerant application:*
           Where A is a set of functions whose domains include the members of B,
           $A(B)=\{\alpha(\beta): \alpha\in A$ and $\beta\in B\}$ (Rooth 1985; Gajewski 2011; a.o.)

(37)   a. LF of (5): [EXH [NEG [*any*$_D$ [*student but*$_D$ *Mary* [1 [*Chris saw* t$_1$]]]]]]

      b. $[\![\,any_D\,]\!]^{ALT}([\![\,student\ but_D\ Mary\,]\!]^{ALT})=$
           $\{\lambda Q_{<e,t>}.\ \exists x[x\in(D'\cap S_w-P')$ and x smokes]: $D'\subseteq D$ and $P'\subseteq\{M\}\}$

      c. TC: $\neg\exists x[x\in(D\cap S-\{M\})$ and Chris saw x], and
           $\forall D'\subseteq D\forall P'\subseteq\{M\}[\neg\exists x[x\in(D'\cap S-P')$ and Chris saw x] $\rightarrow$
                        $(D'\cap S-P')\subseteq(D\cap S-\{M\})]$

We however have seen that *any …but…* is not grammatical everywhere *any* is; as shown in (7), in the so called 'Strawson Downward-Entailing' environments, *any*, but not *any…but …*, is grammatical.

(7)   a. Only Alan talked to <u>any</u> students (**but Mary*).

      b. Chris is surprised/sorry that Alan talked to <u>any</u> students (**but Mary*).

      c. The most senior faculty member who talked to <u>any</u> students (**but Mary*) got promoted.

Note that these SDE environments are presuppositional (see. e.g., von Fintel (1999)); for instance, *only Alan talked to any students* presupposes that someone talked to some student.[6] In these environments, a DE inference is valid only on the grounds where the presupposition of the conclusion is satisfied. The contrast between (5) and (7) then suggests that it is the presuppositions in these SDE environments that block the license of the *but*-EP; while the license of the *any* is not subject to the presuppositional content, that of the *but*-EP is.

There are two routes that can be taken to cash out this contrast. One may follow Gajewski and Sharvit (2012) and assume that the presuppositional meaning normally undergoes exhaustification alongside the assertive meaning; while the license of the *but*-EP is subject to exhaustification over the assertative meaning as well as that over the presuppositional meaning, only the former plays a role in the license of the weak NPI *any*. On the other hand, following Gajewski (2011) and Chierchia (2013), one may assume that exhaustification, in some cases (e.g., for the purpose of licensing strong NPIs such as *in days/weeks/years*, *not. . . until* and *either*), has to operates on the assertive meaning enriched with the presupposition and, in some cases, the scalar implicature (i.e., the conjunction of the assertive meaning and the presupposition or the scalar implicature in question)). Under either possibility, the *but*-EP is ungrammatical in (7) becuase the presupposition of the prejacent of EXH leads to contradiction in the truth conditions (see (38)) when exhaustification applies.

(38) a. LF of (7a): [EXH [*only* [[*any*$_D$ *student but*$_D$ *Mary*]$_1$ [1 [Alan$_F$ talked to t$_1$]]]]]
      b. presuppositional meaning of the prejacent:
            $\exists x \exists y[\ y \in (D \cap S_w - \{M\})$ and x talked to y]
          assertive meaning of the prejacent:
            $\neg \exists x[x \neq$ Alan and $\exists y[\ y \in (D \cap S_w - \{M\})$ and x talked to y]]

The FCI *any* hosts a *but*-EP (see (6)). The nature of the FCI incarnation of *any* has been of much debate. In one view (e.g., Dayal 1998), the FCI *any* has been seen as a lexical item independent of the NPI *any* and has been taken to be a universal quantifier. Under this view, it is expected that a *but*-EP is grammaical with the FCI *any*. In another view (e.g., Chierchia 2006, 2013; Giannakidou 2001) the FCI and NPI incarnations of *any* stem from the same lexical item; the unversal quantificational force of the FCI *any* is due to some mechanism triggered by other operators in the given environment. Under such a view, to account for the grammaticality of the *but*-EP hosted by the FCI *any*, it is only required that exhaustification over the alternatives triggered by *but* occurs above whatever mechanism that gives rise to the universal quantification force. Due to the space limit, I simpy refer the reader to the references cited above.

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[6]Likewise, *be surprised/sorry* and the superlative *-est* trigger presuppositions as well: *Chris is surprised that Alan talked to any student* presupposes that Alan talked to some student; *The most senior faculty member who talked to any tudents got promoted* presupposes that there is some faculty member x such that x talked to some student and there is some degree d such that x is d-senior (see von Fintel (1999)).

(6)   Bill may pick <u>any</u> flavor of ice cream *but toffee*.

6. Conclusion

In this paper, I have shown that there is a total analogy between the weak NPI *any* and the *but*-exceptive. Couched on the exhaustification-based approach á la Chierchia (2006, 2013) to NPI licensing, I have suggested that the *but*-exceptive, just like the NPI *any*, triggers a set of alternatives that are built on the subdomains of the domain of quantification; the license of the *but*-exceptive, just like that of *any*, is subject to the result of exhaustification over the domain alternatives. To the extent that the proposal is on the right track, the analysis suggested provides even stronger support for Gajewski's (2013) claim that the *but*-exceptive should be seen as an instance of strong NPIs.

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The English Perfect is Past[1]

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Abstract. This paper argues that the English Perfect is uniformly an embedded Past. This paper shows that differences in meaning between Present Perfect and Past, which are apparently problematic for this theory, are due to the requirement that frame adverbials merge high and directly interact only with the highest tense. Despite attaching high, frame adverbials constrain event time, in the same way modals may constrain temporal interpretation at a distance (Klecha 2016).

Keywords: tense, aspect, perfect, adverbs, frame adverbials, temporal adverbials

1. Introduction

It is well known that in many ways the English Perfect (1) has a very similar meaning to the English Past Tense (2).

(1) John has left.

(2) John left.

As Reichenbach (1947) noted, both constructions convey anteriority of the time associated with the eventuality described by the verb (event time, henceforth ET) with respect to another time. Reichenbach likened the Simple Past to the Present Perfect in that both place event time prior to utterance time (UT). According to Reichenbach, they differ in terms of the placement of a third time parameter, Reference Time (RT); RT coincides with UT in the case of Present Perfect, and with ET in the case of the Simple Past.

Since Reichenbach, temporal semanticists have of course sought to explain the meanings of sentences like (1) and (2) compositionally, rather than by reference to constructions, which as it turns out are clearly divisible into smaller morphological units. The Present Perfect, for example, seems very clearly to be composed of the Present Tense, and a second thing, which we may call the Perfect. A Neo-Reichenbachian approach to English would therefore say that what Present Tense uniformly accomplishes in that language is to identify[2] RT with UT, and in turn what the Perfect does is to place ET prior to RT.

While it's hard to have clear intuitions about RT (since it is not necessarily associated with either the eventuality described by the verb or the speech event), support for this idea comes from the other things with which the Perfect may combine, for example, past tense.

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[2]Or associate by some other relation, like *overlap*.

(3)   John had left.

Again, on the Neo-Reichenbachian view, tenses relate UT to RT, thus, in (3), Past Tense places RT prior to UT. Perfect once again places ET prior to RT. In this case, RT may easily relate to a previously mentioned event. For example, in (4b), RT is the event of Daniels walking into the bar, described in (4a).

(4)   a. Daniels walked into the bar.
      b. McNulty had left.

So on this view Past Tense contributes the information that RT is prior to UT, while the Perfect contributes the information that ET is prior to RT.

The compositional approach to this issue can be taken to its logical conclusion by positing that what temporal operators like the Present Tense, Past Tense, and Perfect contribute is not a relation between two specified times, (e.g., UT and RT in the case of Present Tense), but rather, that all of these operators contribute only the temporal relation, while the question of which two times they relate is answered entirely by the compositional procedure. This, of course, has to be true to some extent; it can't be that the Perfect morpheme in (4b), for example, states explicitly that RT is later than McNulty's leaving. It must be that the Perfect morpheme takes a temporal argument, which it then relates to its RT argument. In this case, RT is the contextually provided walking-in event; ET is the syntactically provided leaving event.

This paper advances the argument that the only thing temporal operators contribute is a relation, while composition determines which two times they relate. Specifically, this paper makes this argument for the case of the English Perfect, which, as a consequence of this proposal, is semantically unified with the Past Tense. Since the semantics has no way of knowing whether a particular time is an event time or a reference time, a temporal operator cannot be specific to either of them; which of the two it takes as an argument is determined entirely by syntax.[3] Past Tense, when it is fed UT and RT, behaves as Reichenbach's Simple Past. When it is fed RT and ET, it behaves as one of Reichenbach's Perfect constructions.

The obstacle to all of this is what Klein (1992) calls the Present Perfect Puzzle. While in many cases, the Perfect can be quite readily reduced to the Past semantically, the *Present* Perfect, which on the account dimly sketched so far should be almost indistinguishable from the Past, differs from it in a number of curious ways. To give one quite famous example, it is incompatible with certain past time adverbials (5b); notice that no such incompatibility exists in other cases, seen in (5c-e).

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[3]This is not say that it's impossible to posit a semantics by which ET and RT are distinguishable. For example, many analysis argue that operators like the Perfect do not manipulate the time associated with an event, but rather the event itself; thus there is a type-difference between E(T) and RT. I discuss such proposals below.

(5)   a. John left the day before.

        b. #John has left the day before.

        c. John had left the day before.

        d. John must have left the day before.

        e. Having left the day before, John was unhappy.

The major challenge this paper sets out to overcome, therefore, is this Puzzle – if the Present Perfect is merely the Present plus the Past (and given the assumption of a very light semantics for the Present) why should any differences arise between the Present Perfect and the Past? As I argue in detail below, all of these differences can be identified with the way that these operators interact with temporal adverbials. Given this fact, I propose that the highest temporal operator in any sentence is the only which has a privileged interaction with temporal adverbials, and therefore, the fact that Past fills this role in the case of simple Past, but not in the case of Present Perfect, derives all the crucial contrasts.

Note that this proposal is married to the longstanding proposal that the English Perfect may also be *morphosyntactically* reduced to Past Tense (Hoffman 1966, McCawley 1971, Hoffman 1976, McCawley 1988). On this view, the English form *have/–en* is merely the realization of Past in non-finite contexts, i.e., embedded directly under another Past Tense (5c), embedded directly under a modal auxiliary (5d), or embedding under the adverbial-forming *–ing* (5e). This is supported by the fact that for many verbs, the verbal morphology witnessed in the Past and the Perfect are identical; for example, *leave* is inflected *left* in both (5a) and (5b-e). What is left to be explained, of course, is why for many verbs the morphology is not identical (e.g., *see/saw/seen*), and why the light verb *have* appears, when it does not in the case of the Past. For an account of these facts, see Arregi and Klecha (2015).

This paper proceeds as follows. First I lay out the crucial data that I intend to account for, and sketch how my analysis does so. Then I briefly sketch the analysis in prose. Then I formalize the analysis and provide derivations, before comparing my approach to previous ones and concluding.

2. Ways the Past and Present Perfect Differ

On my analysis, the role of a frame adverbial is to establish the Frame Time, an interval which serves to delimit the range of possible event times. This is essentially similar to the Extended Now or the Perfect Time Span of various accounts of the Perfect (McCoard 1978, Iatridou et al. 2003, Portner 2003, Pancheva and von Stechow 2004), except that the notion is generalized beyond the Perfect. All temporal operators have a Frame Time argument, which may be satisfied by the a frame adverbial. The core of my proposal is that Present Tense, but not the Past, requires that Frame Time overlap its evaluation time. (Typically, and in all cases examined in this paper, the evaluation time of an unembedded temporal operator is utterance time.) Since a Present Perfect clause is one with the Present Tense as its highest temporal operator, it is subject to this restriction; but the Past is

not, since there is no Present Tense present in a simple Past Tensed clause. Crucially, despite the fact that the frame adverbial attaches high, it constrains event time, as is formalized below. In this section I list the main empirical points of divergence between the Present Perfect and the Past, and informally discuss how these differences are accounted for by this proposal, before turning to the complete analysis in following sections.

2.1. Past Time Adverbials

The Present Perfect is, unlike the Past and other Perfects, curiously bad with past time adverbials (PTAs), as illustrated in (5) above. This observation greatly precedes generative linguistics; the earliest observation of it of which I am aware is Pickbourn (1789), who is cited by McCoard (1978). A qualification of this observation comes from Klein (1992), who notes the contrast below, between what he identifies as definite and indefinite PTAs.

(6)   a.   #John has left (on) Sunday.
      b.   John has left on a Sunday.

This motivates Klein to pursue a theory based on the (in)definiteness of temporal adverbials. However, Portner (2003) argues that what matters is not the (in)definiteness of the adverbial, but whether it lexically picks out a past time interval or not. Portner writes: "[I]t is preferable to stick with a description of the relevant phenomenon as precluding any use of a past time adverbial with the English present perfect, understanding "past time adverbial" to refer only to adverbials which themselves entail pastness, not any adverbial which may be used to describe a past event." In the case of the indefinite *a Sunday*, there is nothing inherently posterior about it – it quantifies over all Sundays past, present, and future, and the restriction to past Sundays in (6b) is due to the semantics of the perfect, not the adverb. So for the purposes of the PTA generalization, it doesn't count.[4] Portner points out that replacing *on a Sunday* with *on a Sunday last month*, which is inherently past, generates infelicity judgments.

(7)   #John has left on a Sunday last month.

In my analysis below, I will simply assume that *on a Sunday last month* is not a constituent; if *last month* is its own PTA, distinct from *on a Sunday*, it would independently run afoul of both Portner's ban on PTAs and Klein's ban on definite temporal adverbials. But in the event that such an analysis becomes untenable, I would like to sketch an alternative approach.

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[4]This requires assuming that *(on) Sunday* in (6a) is fixed by the context to refer to a specific Sunday in the past, and that checking whether an adverbial entails pastness by itself happens after context does its work. I discuss Portner's account in more detail below.

First consider (8), which contains a temporal adverbial which is both indefinite and not inherently past oriented. This accords with both Klein's and Portner's versions of the generalization. But next consider (9). The determiner *a* is replaced by *some* which is likewise indefinite, and does nothing to entail pastness. Yet (9) is bad, contrary to both Klein's and Portner's generalizations.

(8)   John has skipped work on a Catholic feast day this year.

(9)   #John has skipped work on some Catholic feast day this year.

This is a matter of scope (or, alternatively, of referentiality). Unlike *a*, the indefinite *some*[5] is known to take necessarily wide scope, as seen in (10-11).

(10)   a. Bill's crying because he didn't see some player at the game. $\exists > \neg$
         b. Charlie has to read some book for his class. $\exists > \Box$

(11)   a. Bill's crying because he didn't see a player at the game. $\exists > \neg$ or $\neg > \exists$
         b. Charlie has to read a book for his class. $\exists > \Box$ or $\neg > \exists$

Thus while *some* scopes outside the interval description formed by the *on*-phrase, *a* may scope inside. So *some* behaves more like a definite than typical indefinites in terms of its scope properties, and for this we can credit Klein's attempted generalization.[6] We can represent the different Frame Times established by the two adverbials as in (12). In the pseudo-formula below, let t range over intervals and u over instants; assume intervals are just sets of instants.

(12)   a. $[\![...\text{on some feast day}]\!]^g = \exists t[\text{feast-day}(t) \ \& \ ...\{u \mid u \in t\}...]$
         b. $[\![...\text{on a feast day}]\!]^g = [...\{u \mid \exists t[\text{feast-day}(t) \ \& \ u \in t]\}...]$

Thus *on some feast day* furnishes the Present Perfect with a particular interval for a Frame Time. This Frame Time cannot be past relative to speech time due to the lexical requirement of the Present Tense; but of course it cannot be future relative to speech time due to the semantics of the Perfect.[7] Since no satisfactory value for t can be found, (9) is judged infelicitous.

Meanwhile, *on a feast day* sets the Frame Time as the (discontinuous) interval consisting of all feast days. This interval's earliest instant is prior to speech time, and its latest is after speech time, so in a sense this Frame Time may be said to overlap speech time. Given a precise characterization

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[5]Not to be confused with indefinite *s'm*, which can combine with only plural or mass nouns.

[6]Alternatively, it could be that *some* appears to always take wide scope because it is in fact referential, while *a* is truly an existential quantifier. Either way, it is definite-like in its scope.

[7]I assume pragmatic considerations prevent the feast day in question from being the day of utterance.

(given below) of the Present's requirement that Frame Time overlap speech time in this sense, we can say that *on a feast day* (and other typically indefinite adverbials) is not a PTA, but *on some feast day* (along with definite adverbials) is, at least for the purposes of the PTA generalization. Thus, the original generalization about the Present Perfect and PTAs is preserved. Moreover Portner's caveat is sharpened, and the importance of Klein's observation can be seen as well.

2.2. Domain Size

When no adverbial is present, Past Tense gives rise to a highly contextualized temporal domain compared to Present Perfect.

(13)   *Al:* I saw Jo at the party.
   a.   *Ed:* Did you talk to her?
   b.   *Ed:* Have you talked to her?

One way to summarize the distinction between these two is again in terms of definiteness; (13a) asks about a talking event at *the salient past time*, while (13b) asks whether there is a talking event at *a(ny) past time*. However, it's also true that Past Tense does not require a definite event time, especially when there is an overt frame adverbial. (14) requires there only to be one event of the speaker seeing Sue, and it may be at any time within Frame Time.

(14)   I saw Sue yesterday.

And indeed, even (13a) does not ask about a specific instant of time – rather, it asks whether there are any talking events *during* the party, whose runtime here acts as Frame Time. Thus I argue that every tensed clause has a Frame Time, and in the absence of an overt frame adverbial, this is contributed by context.

So both Past and Present Perfect can be construed as being indefinite, in the sense of introducing existential quantification over times;[8] in (13) they only differ in the size of the domains that their existential quantifiers range over, i.e., Frame Time. While (13a) asks about talking events *at the party*, (13b) asks about talking events *since the party* or perhaps *ever* – both are acceptable.

As captured by the analysis I present below, this reduces to the first observation, that the Present Perfect is incompatible with PTAs. The Frame Time in (13a) is not constrained to overlap speech

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[8]In fact I will assume that existential quantification comes from a covert quantifier, which is complementary distribution with quantificational adverbials like *always*, but this point is not relevant now.

time, so it can be freely identified with the salient interval, namely the runtime of the party. The Frame Time in (13b), however, must overlap speech time, so in this context, a satisfactory Frame Time must be accommodated. Considerations of relevance may require that this interval also has something to do with the the party – thus we may end up with a domain that extends from the party to beyond speech time. But we just as easily can end up with the maximal interval, if the resulting assertion can be construed as relevant.

2.3. Lifetime Effects and Their Ilk

So-called lifetime effects can be observed with the Present Perfect cases but not the Past. Thus the contrast in felicity judgments between (15b-15c) correlates with the livingness of the subject.[9] No such contrast exists with the simple Past (cf. (15a)). A similar case is the unacceptability of (16b), noted by McCoard (1978) and highlighted by Portner (2003); compare to the acceptability of (16a).

(15)   a. Einstein visited Princeton.

        b. #Einstein has visited Princeton.

        c. Obama has visited a federal prison.

(16)   a. Gutenberg invented the printing press.

        b. #Gutenberg has invented the printing press.

Inoue (1979) argues that (15b) is bad because the event it describes is not repeatable at speech time. The same can be said of (16b). For Inoue, this is because repeatability at speech time is simply a consequence of the *current relevance* of the event, or of the event description. Thus, for her, Present Perfect and Past differ in that only the former requires an element of current relevance; many other analyses share a similar element. I agree with Inoue's proposal that the contrast in (15) is about repeatability,[10] and argue that this extends to (16). I do not agree, however, that this has anything to do with current relevance. Rather, I argue that this is an implicature which arises by comparison with the Past Tense.

Use of the simple Past Tense conveys that no events bearing the description provided by the VP will occur after speech time[11] and within Frame Time. I will call this the Future Non-occurrence Inference (FNI); I am not aware of any author who has previously made this observation.[12] Contrast

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[9]Importantly, at the time of the writing of this paper, Albert Einstein is dead, and Barack Obama is alive.

[10]Strictly speaking, I argue that it's about future occurrence rather than repeatability.

[11]More carefully, evaluation time.

[12]Many authors (e.g., Altshuler and Schwarzschild 2013) have discussed the simple Past's Cessation Inference, the inference – triggered by use of Simple Past with a stative predicate – that the state described by the VP does not hold at present. I believe these are a special case of the FNI, but I do not have space to give this argument proper support.

(17a) and (17b). While (17b) allows the possibility that the addressee will eat between speech time and the end of the day, (17a) conveys that the addressee will not eat during that period. Likewise, (18a) gives rise to the inference that that John will not get up to talk again today, while (18b) leaves that possibility open.

(17)   a. Did you eat today?

       b. Have you eaten today?

(18)   a. Every time John got up to talk today, you burst out laughing.

       b. Every time John has gotten up to talk today, you have burst out laughing.

Two points must be made in order to explain the contrasts in (15-16) by way of the contrast in (17). First, although Past is lexically associated with the FNI, it does not appear when Past is embedded under Present, i.e., in the Present Perfect. In the next section, this is shown to follow from the formalization of the proposal (mentioned above) that only the highest temporal operator in a given clause interacts with that clause's frame adverbial. Thus, although the embedding of the Past under the Present has a very limited semantic effect, one effect it does have is to essentially eliminate the FNI.

The second point is that a speaker who wishes to describe a past event of Einstein visiting Princeton has a choice between uttering (15a) and (15b). As argued by Stump (1985), such a speaker will be inclined to select the less marked one, i.e., the Simple Past.[13] Because the Simple Past is less marked, choosing the Present Perfect gives rise to the implicature that the Simple Past cannot be honestly uttered.[14] If the frame adverbial overlaps the present, satisfying Present's requirement, then the Past and Present Perfect are identical, except for the FNI. Thus, choosing the Present Perfect implicates a denial of the FNI – in other words, it implicates that there at least *could be* more instances of the VP-event in the future portion of Frame Time.[15] This is inappropriate in the cases of Einstein's visit to Princeton or Gutenberg's invention of the printing press, since these events are not repeatable.

One further wrinkle involving lifetime effects is that they seem to be particularly sensitive to the subject. The following contrast was first observed by Chomsky (1970).

(19)   a. #Einstein has visited Princeton.

       b. Princeton has been visited by Einstein.

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[13]Note that the present analysis makes a very good case for the unmarkedness of the Past compared to the Present Perfect; the Past consists of a morphosyntactic subset of the Present Perfect.

[14]Alternatively, this could be handled by appeal to Maximize Presupposition (Schlenker 2012), or exhaustivity operators in syntax. See also Pancheva and von Stechow (2004) for another account which relies on pragmatic comparison of Present Perfect and Past.

[15]This is slightly different from Inoue's formulation, which is that the VP-event be repeatable *at* speech time.

What this suggests for the present analysis is that the implicature normally derived by comparison with the equivalent Past sentence is not available. Consider the simple Past version of (19a); its acceptability depends greatly on the context.

(20)   a. Tell me something interesting about an Ivy League school.

      b. #Princeton was visited by Einstein.

(21)   a. Tell me about something interesting that happened in 1947.

      b. Princeton was visited by Einstein.

Given a context where there is no salient Frame Time, we are likely to accommodate the maximal interval as the Frame Time. With such a Frame Time, the Future Inference produced by the Past is that Princeton will be the recipient of no further visits ever (perhaps because Princeton is no more); thus the infelicity judgment. In a context where the salient Frame Time is the year 1947, no special inference arises; this is because the year 1947 is entirely prior to speech time, so the requirement that there be no visits to Princeton after speech time and within Frame Time is trivially satisfied.

What's surprising about (19b) and (20) is that they seem to indicate that, for the purposes of the Future Inference, what is meant by 'VP-event' indicates visits by Einstein to Princeton in (19a), but simply visits to Princeton in (19b). Thus, it cannot be that the Past tense takes its complement to strictly, compositionally determine the event description that is relevant for the Future Inference. Rather, it must be that the event description at play in the Future Inference is determined by context, and with the compositional semantics having a strong but not deterministic influence on said context.

2.4. The U-Perfect

Consider (22). It can be answered affirmatively in two distinct situations (among others) given in (23a-23b).

(22)   Has John been in the garden since 5?

(23)   a. There was an interval between 5 and now in which John was in the garden.

      b. At every interval between 5 and now, John was in the garden.

These two verifying conditions are sometimes characterized as distinct readings, prompting the terminology *existential perfect* and *universal perfect*. What is relevant here is not so much the duration of the state being described, but whether it continues at speech time or not. This is possible with the Perfect but not the Past. (24a) is compatible with a situation where the being-here-state continues through speech time, while (24b) is not.

(24)   a. I have been in the garden all day.

        b. I was in the garden all day.

The inability of the Past to allow for continuation into the present is accounted for by the Future Inference discussed above. The Future Inference requires that (24b) is only acceptable if there are no states of the speaker being in the garden in the future, within the day in question. Since the semantics of *all day* requires that the state of being in the garden lasted the entirety of the day in question that has so far elapsed, the Future Inference can only be verified in a situation where either i) the day in question is over, or ii) the state will not persist at all into the future.[16] In the former case, utterance time is not contained in the day in question, thus the sentence does not entail that the being-in-the-garden state extends to utterance time. In the latter case, since the state will not persist at all into the future, it cannot reasonably extend into the present, given the infinitely small gap between the present and the future.[17]

I consider (22) and (24a) to be cases of generality rather than ambiguity (a la Inoue 1979), so my account won't say anything special about the distinction between the so-called existential and universal readings. However, a bit more does need to be said about *since*, a frequent constituent of universal perfects. It can appear with the Perfect, but not the Past (25).

(25)   #Was John in the garden since 5?

But this is due to the peculiar nature of *since*. It is a frame adverbial, and thus, contributes Frame Time. But it is also parasitic upon reference time, which it uses to determine the right bound of Frame Time. Since in the case of the Past, reference time is event time, if Past combines with *since*, event time will required to be at reference time but within Frame Time, an impossibility. Only in the case of the Perfect, when RT and ET are dissociated, is *since* usable.

2.5. Results and Relevance

The Present Perfect can have so-called result state readings, which the Past cannot.

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[16]As with all things, allowances must be made for imprecision. (24b) can be truthfully and felicitously uttered if the day is not technically over and the state will technically persist into the future, so long as the day is *essentially* over, or the state will not persist *substantially* into the future. See Lasersohn (1999), Lauer (2013), Klecha (2014a).

[17]It could be argued that all states that end have a last moment, and we could ask ourselves about the truth of (24b) in a situation where the last moment of the speaker being the garden was speech time. I'm not sure it's possible to get clear judgments about such cases, but to be safe we could alter the Future Inference so that it excluded VP-eventualities in the future *and* present. Either way, this inference is neutralized when Past is embedded under Present, so it has no effect on the Perfect.

(26)   *John walks in to find the room torn apart and Bill laying on the floor, with no glasses on.*
   a. *Bill:* I lost my glasses.
   b. *Bill:* I have lost my glasses.

(27)   *Same context, but Bill is wearing his glasses.*
   a. *Bill:* I lost my glasses.
   b. *Bill:* #I have lost my glasses.

While the Past is fine in both contexts, the Present Perfect can seemingly only be used in the context where the result state of the event described by the VP holds at speech time. In the cases above, the event described by the VP is a glasses-losing event, so the result state is a state of the glasses being missing. This is one fact which the present analysis does not capture. But it may yet be given a pragmatic explanation; again this would rely on the notion that a speaker must have a good reason for uttering the more marked form over the less marked one (see Lauer (2013) for more on implicatures of this sort). In this case, the choice of FT which extends beyond ET all the way to the present implicates that something relevant is true in the interval between ET and present. Unfortunately, this is not as easy to formalize as the scalar implicature analyzed to above, and risks falling into the pragmatic wastebasket. More needs to be said on the topic.

3. The Analysis, Informally

In this section I sketch out the complete picture of the analysis, before formalizing it in the following section.

3.1. Adverbs

As is discussed in more detail below, all temporal operators have a Frame Time argument, which frame adverbs, like those listed in (28), satisfy. The tenses are also associated with temporal indices, which correspond to Reference Time, and which may be bound by frequency adverbs, like those listed in (29).

(28)   *Frame Adverbs:* pro_n, yesterday, last month, since XP, at XP...
(29)   *Frequency Adverbs:* $\emptyset_\exists$, once, every time, three times, all day...

Two adverbs should be noted here: The pronominal frame adverb and the existential frequency adverb, both of which are covert. Importantly, there is no covert existential frame adverb.

Frame adverbs attach high in the structure, above all temporal operators. As has been alluded to before, this is what allows Present Tense to interact with the adverbs in the case of Present Perfect,

thus ruling out any frame adverbs which do not overlap evaluation time. Klein (1992), however, rejects this possibility on the basis that frame adverbs can modify event time. This is certainly true; consider (30).

(30)   Today I have sneezed three times.

Clearly, *today* acts as a domain restrictor to *three times*. It clearly constrains the range of possible event times, and not reference time; if it constrained the latter, it would so entirely without informative affect.

However, as Klecha (2016) has argued, certain expressions may constrain the range of possible temporal interpretation at a distance. Klecha in particular examines modals and attitude verbs which constrain the possible value of RT of the clauses they embed, despite not have a local compositional relationship with the tenses of those clauses. For example, *think* allows for present/past RTs, while *hope* additionally allows for future times (31). Thus I argue that frame adverbials, through the same mechanism, constrain event time, despite attaching high. The formal details are given in the next section.

(31)   a. John thinks she feels better {today/*tomorrow}.
        b. John hopes she feels better {today/tomorrow}.

One last stipulation: I assume that Frame Adverbials (at least referential ones, which can satisfy the FT argument of the highest temporal operator) are mediated by a functional head (F[FT]), whose order is fixed relative to other (quantificational) frame and frequency adverbs.

(32)   a. Peter denied the lord [three times]$_{Freq}$ [tonight]$_{Frame}$.
        b. $^?$Peter denied the lord [tonight]$_{Frame}$ [three times]$_{Freq}$.
(33)   a. Peter denied the lord [three days]$_{Frame}$ [this week]$_{Frame}$.
        b. *Peter denied the lord [this week]$_{Frame}$ [three days]$_{Frame}$.

3.2. Temporal Operators

Each temporal operator (tense or aspect) relates three temporal arguments: An evaluation time, a reference time, and a frame time (FT) a la von Stechow (1995). The evaluation time argument of each temporal operator is represented in the present theory as a lambda-abstract, and is thus controlled by the temporal operator which embeds it (namely, it is satisfied by the RT of the embedding temporal operator). The reference time argument of each temporal operator is represented

as an index on the temporal operator. Thus the reference time is interpreted as a variable, to be bound by a quantificational operator (by default, an existential).

I model FT as a lambda-abstracted argument as well. This is because FT is in many cases saturated by a non-binding operator, like *yesterday* or *today*. However, as mentioned above, frame adverbs must be constrained to only combine with the highest temporal operator in a clause, to prevent, for example, *yesterday* combining with a Past Tense that is embedded under a Present in the Present Perfect. For this reason I assume that Present and Past tense both bear a second index, corresponding to a FT, which they plug into the FT argument of the temporal operator below them. Thus it is only the highest temporal operator that has a FT argument that can be freely saturated by referential frame adverbs, introduced by F[FT]. Another function of F[FT] is to existentially close any FT-variables or RT-variables still free in its complement. But this still allows for the binding of the FT of lower temporal operators by quantification frame adverbs which appear below F[FT]. An example of this is in (34); while *this month* provides FT for Present Tense, *(on) every Tuesday* binds FT of the embedded Past, i.e., the Perfect.

(34)   This month, I've danced every Tuesday.

The heart of the analysis is that Present and Past Tense each impose distinct requirements on their FT. Present Tense requires that its FT overlap or abut its evaluation time. Past Tense requires there be no VP-type events after its evaluation time and within its FT. Embedding Past Tense under Present Tense produces a semantics which is very similar to the Past Tense, in that event time must ultimately be in the past, but differing in the inferences regarding FT. Since Present is highest temporal operator, FT must overlap utterance time. Moreover, Past Tense's requirement, the FNI, is essentially eliminated, because its FT is existentially closed by F[FT]. Thus the FNI is true as long as some interval can be found such that there are no VP-type events at a time after the evaluation time of the embedded Past Tense and within the interval. If the interval $(-\infty, x]$ is chosen (where x is the evaluation time of Past Tense), then the FNI is trivially true.

4. The Analysis, Formally

I assume a $W \times T$ frame (Thomason 1984) plus events (Davidson 1967). I use $\langle \epsilon \rangle$ as the type for events; $\langle t \rangle$ for truth values; $\langle s \rangle$ for worlds; and $\langle i \rangle$ for times. An interval is a set of times, type $\langle i, t \rangle$. Following (Klecha 2016), a *history* (type $\langle h \rangle$) is a world-interval pair.[18] Some more notational devices: If $h = \langle w, T \rangle$, then $\omega_h = w$ and $\tau_h = T$, while τ_e is the run-time (an interval) of an event e. A few more important notational elements:

(35)   a. $act(w, t) := \langle w, (-\infty, t] \rangle; fut(w, t) := \langle w, (t, \infty) \rangle$
       b. $RB(T) := \iota s[\forall t[\neg\exists u[u < t \ \& \ \forall v \in T[u > v]] \rightarrow s \leq t]]$

---

[18] I use s, t, u, v as variables for instants, S, T, U, V for intervals, w for worlds, and h, i, j, k for histories.

    c. $T \mathbin{\underline{\circ}} u := 1$ iff $LB(T) \leq u \leq RB(T)$

    d. $h|U := \langle \omega_h, \tau_h \cap U \rangle$

The actual history a world w at t (35a) is the history which has w as its world component and the interval $(-\infty, t]$ as its temporal component; the future of a world w at t is the same history but with (t, ∞) as its temporal component. The right boundary (RB) of an interval T (35b) is defined whether or not T has a right-most instant; so, if $T = (x, y]$ and $U = (x, y)$, $RB(T) = RB(U) = y$; left boundary (LB) is defined likewise. An interval T quasi-overlaps an instant u (35c) iff u is in T *or* u is either the left or right boundary of T; given the definition of left and right boundary, T can quasi-overlap u without overlapping it. Finally, $h|U$ (35d) is merely the history which is just like h except its temporal component is intersected with U.

I assume a declarative sentence has the type $\langle i, ht \rangle$, where a sentence S uttered in world w at time t is true iff $[\![\text{S}]\!]^g(t)(act(w, t)) = 1$. I assume that VPs are of type $\langle \epsilon, st \rangle$. I will use $\langle a \rangle$ as the type for assignments; this will be necessary to model the binding functions of certain expressions (F[FT]). Functional elements relevant to temporal interpretation are hierarchically ordered according to (36); their denotations are given in (37).

(36)   F[FT] (>F[RT]) > T (> T[PST]) > Asp > VP

(37)   *The Functional Inventory*

    a. $[\![\text{Asp[IMP]}]\!]^g = \lambda P_{\langle \epsilon, st \rangle} \lambda T \lambda v \lambda h [\exists e[P(e)(\omega_h) \mathbin{\&} v \subseteq \tau_e \mathbin{\&} \partial v \in \tau_{h|T}]]$

    b. $[\![\text{Asp[PRF]}]\!]^g = \lambda P \lambda T \lambda v \lambda h [\exists e[P(e)(\omega_h) \mathbin{\&} \exists t \in \tau_{h|T}[\tau_e = [v, t] \mathbin{\&} \partial v \in \tau_{h|T}]]]$

    c. $[\![\text{T[PRS]}_{j,k}]\!]^g = \lambda R_{\langle it, iht \rangle} \lambda T \lambda v \lambda h [g(j) \geq v \mathbin{\&} R(g(k))(g(j))(h|T) \mathbin{\&} \partial T \mathbin{\underline{\circ}} v]$

    d. $[\![\text{T[PST]}_{j,k}]\!]^g = \lambda R_{\langle it, iht \rangle} \lambda T \lambda v \lambda h [g(j) < v \mathbin{\&} R(g(k))(g(j))(h|T) \mathbin{\&} \partial \neg \exists t[R(T)(t)(fut(\omega_h, v))]]$

    e. $[\![\text{F[FT]}]\!]^g = \lambda \hat{R}_{\langle it, ihat \rangle} \lambda T \lambda v \lambda h [\exists g' \approx_\tau g[\hat{R}(T)(v)(h)(g')]]$

For lack of space, I will not discuss the semantics of the aspectual heads. The symbol ∂ is used to introduce presuppositions. Each tense's restrictions on FT are modeled as presuppositions. They are clearly projected, given their persistence in, e.g., question environments – but the specific choice of presupposition rather than another kind of projected inference is purely an assumption. Note that the Present Tense's FT presupposition is stated with quasi-overlap; this allows for apparently past time frame adverbials which are nonetheless acceptable (*before*, *recently*, etc.). Note also that Present Tense is given here as a non-past. The definition of truth above, which builds in a non-future temporal frame, accounts for the usual inability of the Present to achieve future reference in matrix contexts; see Kaufmann (2005), Klecha (2016) for more details.

Let $g' \approx_\tau g$ in (37e) be true iff g' is an assignment just like g, except regarding the values of time-denoting variables. The frame-time adverbial head F[FT] therefore existentially closes any free time-denoting variables in its scope. Thus any RT or FT variable will be existentially closed,

unless a frequency adverb appears below F[FT] to bind RT of an operator, or a quantificational frame adverb appears below F[FT] to bind FT of an operator. This captures the requirement seen in (32) and (33) that frequency adverbs and quantificational frame adverbs must scope below (appear to left of) a referential frame adverb. Since these kinds of adverbs bind open variables, such variables must still be open to be bound by them. Referential frame adverbs cannot appear below F[FT] because a) they cannot bind variables, and b) they cannot satisfy the FT argument of the highest tense (this would create a type clash with F[FT]). Referential frame adverbs cannot bind variables because temporal adverbs in general cannot undergo QR, as witnessed by the fact that sentences with multiple quantificational temporal adverbs can only take surface scope (38).

(38) a. I ate meat on a Friday three times that year. $3 > \exists; \#\exists > 3$
      b. I ate meat three times on a Friday that year. $\#3 > \exists; \exists > 3$

We are now in a position to give an analysis for *since* which captures its incompatibility with the simple Past (seen in (25)). This badness is due to a peculiar property of *since* – it is *essentially* a frame adverb, but it makes use of RT to construct FT. This actually requires *since* to be in complementary distribution with F[FT]. It also must be stipulated that *since*'s index match that of the highest temporal operator in the clause.

(39) $[\![since_j]\!]^g = \lambda t \lambda \hat{R}_{\langle it, ihat \rangle} \lambda v \lambda h [\exists g' \approx_\tau g [\hat{R}([t, g'(j)))(v)(h)(g')]]$

4.1. Sample Derivations

(40) I didn't check the mail today.

(41) I haven't checked the mail today.

(42) *Structure of (40)*

```
              S
           /     \
        not       FP
               /      \
          /        \    today
      F[FT]        TP
               /        \
      T[PST]_2,6        AspP
                      /      \
                Asp[PRF]      VP
```

(43) *Structure of (41)*

```
              S
           /     \
        not       FP
               /       \
          /         \    today
      F[FT]         TP
               /        \
      T[PRS]_4,8         TP
                      /       \
                T[PST]_2,6    AspP
                            /      \
                      Asp[PRF]      VP
```
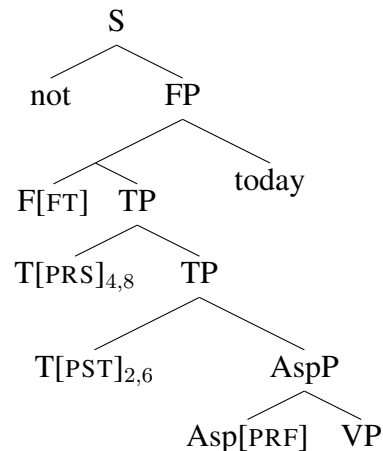
(44)   *Unreduced Truth-Conditions of 42, uttered in w at t_0 under assignment g*
$\neg\exists t_2, U_6[t_2 < t_0$ & $\exists e[\text{check-mail}(e)(\omega_{\langle w,(-\infty,t_0]\rangle|\text{day}(t_0)})]$ & $\exists u \in \tau_{\langle w,(-\infty,t_0]\rangle|U_6|\text{day}(t_0)}[\tau_e =$
$[t_2, u]]$ & $\partial t_2 \in \tau_{\langle w,(-\infty,t_0]\rangle|U_6|\text{day}(t_0)}$ & $\partial\neg\exists v[\exists e'[\text{check-mail}(e')(\omega_{fut(\omega_{\langle w,(-\infty,t_0]\rangle},t_0)})$ &
$\exists s \in \tau_{fut(\omega_{\langle w,(-\infty,t_0]\rangle},t_0)|\text{day}(t_0)}[\tau_{e'} = [v, s]]$ & $\partial v \in \tau_{fut(\omega_{\langle w,(-\infty,t_0]\rangle},t_0)|\text{day}(t_0)}]]]$

As in Cable (2013) I assume that presuppositional content applied to a variable which is existentially bound outside of the presupposition reduces to non-presuppositional content. Applying this reduction, as well as reducing the omega and tau terms, and eliminating the trivial U_6 yields (45).

(45)   *Reduction of (44)*
$\neg\exists t_2[t_2 < t_0$ & $\exists e[\text{cm}(e)(w)]$ & $\exists u \in [LB(\text{day}(t_0)), t_0][\tau_e = [t_2, u]]$ & $t_2 \in [LB(\text{day}(t_0)), t_0]$
& $\partial\neg\exists v[\exists e'[\text{cm}(e')(w)$ & $\exists s \in (t_0, RB(\text{day}(t_0))][\tau_{e'} = [v, s]]$ & $v \in (t_0, RB(\text{day}(t_0))]]]]]$

Eliding some aspectual details, (45) entails that there is no time t_2 prior to t_0 but within the day of utterance at which a mail-checking event occurred, and presupposes that there is no time after t_0 within within the day of utterance at which there are any mail-checking events.

(46)   *Unreduced Truth-Conditions of (43), uttered in w at t_0 under assignment g*
$\neg\exists t_2, u_4, U_6, V_8[u_4 \geq t_0$ & $t_2 < u_4$ & $\exists e[\text{check-mail}(e)(\omega_{\langle w,(-\infty,t_0]\rangle|V_8|\text{day}(t_0)})]$ & $\exists u \in$
$\tau_{\langle w,(-\infty,t_0]\rangle|U_6|V_8|\text{day}(t_0)}[\tau_e = [t_2, u]]$ & $\partial t_2 \in \tau_{\langle w,(-\infty,t_0]\rangle|U_6|V_8|\text{day}(t_0)}$ &
$\partial\neg\exists v[\exists e'[\text{check-mail}(e')(\omega_{fut(\omega_{\langle w,(-\infty,t_0]\rangle}|\text{day}(t_0),t_0)})$ & $\exists s \in \tau_{fut(\omega_{\langle w,(-\infty,t_0]\rangle}|\text{day}(t_0),t_0)|V_8}[\tau_{e'} =$
$[v, s]]$ & $\partial v \in \tau_{fut(\omega_{\langle w,(-\infty,t_0]\rangle}|\text{day}(t_0),t_0)|V_8}$ & $\partial\text{day}(t_0) \circeq t_0]]]$

(47)   *Reduction of (46)*
$\neg\exists t_2[t_2 < t_0$ & $\exists e[\text{cm}(e)(w)]$ & $\exists u \in [LB(\text{day}(t_0)), t_0][\tau_e = [t_2, u]]$ & $t_2 \in [LB(\text{day}(t_0)), t_0]$
& $\partial\text{day}(t_0) \circeq t_0]$

(48)   *Implicature of (43), uttered in w at t_0 under assignment g*
$\Diamond\exists v, e'[\text{cm}(e')(w)$ & $\exists s \in (t_0, RB(\text{day}(t_0))][\tau_{e'} = [v, s]$ & $v \in (t_0, RB(\text{day}(t_0))]]]]$

The definition of truth requires u_4 to be t_0; U_6 and V_8 can be eliminated as before. Crucially, the entire presupposition contributed by Past Tense can be eliminated as well, since it is trivially easy to find an interval which does not contain a time after t_0 at which mail is checked (namely, any interval which ends at or before t_0). As discussed above, the choice of Present Perfect over Past implicates that Past's presupposition may be false;[19] this is given in (48). This implicature is what captures lifetime effects. Note also that substitution of the adverb *today* with past-time referring one (like *yesterday*) would clearly give rise to presupposition failure.

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[19]More carefully, the implicature is that the presupposition simply *is* false; this requires amending the Past's presupposition to be something more along the lines of "in no worlds is there a time...". A related concern is that, following Klecha (2014b), future reference requires mediation by a modal. Inserting a modal element into Past's presupposition solves both of these issues.

5. Conclusion and Comparison

This account is most similar to Portner (2003) and other 'extended now' accounts. This analysis, however, replaces the extended now with the notion of Frame Time, which is not specific to the Present or the Perfect. It also provides a formal, compositional analysis for how adverbs directly determine Frame Time. Like Inoue (1979), I argue that the Present Perfect gives rise to a repeatability inference, which accounts for lifetime effects. However, unlike Inoue I argue this repeatability inference arises by comparison to a non-repeatability inference which is lexically associated with the Past. As far as I know, I am the first to propose that Past is associated with this inference.

Most of all, this account differs from recent attacks on the Present Perfect Puzzle in that it is also unifies Perfect with Past. Crucially, while embedding Past under Present has no effect on primary entailments, it introduces a distinct presupposition (requiring FT to overlap speech time) while neutralizing the usual presupposition of Past, which is replaced with the implicature of repeatability. Naturally, this account requires a morphosyntactic account to go along with it; for that, see Arregi and Klecha (2015).

I do not claim that constructions labeled "Perfect" cross-linguistically are embedded Pasts, although it's possible many could be. There is a lot of room for crosslinguistic variability; any given language may lack the overlap requirement on its Present Tense; or the FNI on the Past Tense; or may have different presuppositions in their place. Many languages (e.g., Palatinate German) may lack a Simple Past[20] entirely, which would prevent any implicature arising by comparison of Present Perfect to Past. Languages may have distinct operators which trigger spell-out of the equivalent of *have*, but which are not the Present Tense; thus in these languages what is glossed as Present Perfect may consist of OP + PAST, for some yet unanalyzed OP.

Many details here are left unspecified or require significant further elaboration. These unspecified details and unelaborated elaborations will have to wait, for reasons of space. However this paper has shown that an analysis of Perfect as Past can account for the Present Perfect Puzzle at least as well as any other.

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[20]In other words, Past in these languages is required to be embedded under Present.

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On Quotational Indefinites[1]

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Abstract. This paper discusses QUOTATIONAL INDEFINITES, an understudied variety of indefinites that is attested in languages like Bulgarian and German (see Cieschinger & Ebert 2011 on the latter), and are akin to Japanese *wh*-doublets (see Sudo 2008) and English placeholders like *whatshisface* or *so-and-so* (cf. Clark & Gerrig 1990). My major claim is that quotational indefinites existentially quantify over linguistic expressions and make reference to both expressions and their denotations. In addition, such indefinites require that the expressions they quantify over are of a certain type (a referential expression, a particular kind of adverbial, etc.) and originate in a previous conversation. This work uncovers important interactions between indefiniteness, quotation, and reportativity, and broadens our understanding of the typology of indefinites.

Keywords: indefinites, quotation, reportativity, two-dimensional semantics.

1. Introduction

This paper studies QUOTATIONAL INDEFINITES (QIs), a less-known variety of indefinites which range over quoted speech. Building on previous work on QIs in German (Cieschinger & Ebert 2011) and indefinite forms with related properties in Japanese (Sudo 2008), I provide fresh data from Bulgarian and offer a uniform account which captures their distribution and core semantic properties.

The phenomenon of quotational indefinites is illustrated below for Bulgarian (1) and German (2).[2]

(1) Maria izliza-l-a   s   *edi-koj si*.
    Maria go.out-EV-FEM with QI.MASC

    'Maria is dating someone.'
    ⤳ 'Maria's date was mentioned to the speaker in a previous conversation.'

(2) Luise hat gesagt, dass *die*   *und die*   von der Schule geflogen ist.
    Luise has said   that the.FEM and the.FEM from the school expelled is

    'Luise said that someone has been expelled from school.'

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[2]Abbreviations in glossed examples: 1SG = first person singular (etc. for other persons and numbers), ACC = accusative, C = declarative complementizer, DAT = dative, DEF = definite, EV = evidential, FEM = feminine, MASC = masculine, NEUT = neuter, PAST = past tense, PL = plural, PP = past participle, REFL = reflexive, TOP = topic.

⤳ 'The person expelled from school was identified in a previous conversation.'

(Cieschinger & Ebert 2011: 176; slightly modified)[3]

The Bulgarian DP *edi-koj si* in (1) has an indefinite-like meaning. The core proposition expressed by the sentence is that Maria is dating someone. The sentence also implies that the speaker heard a referring description of Maria's date in a previous conversation. This REPORTATIVE IMPLICATION is due to the presence of *edi-koj si*, as witness the fact that substituting it with the regular indefinite *njakoj* 'someone.MASC' removes the implication. German indefinites of the form *die und die* have a similar meaning, as seen from (2).

What are the semantic properties of QIs and how can these be derived from the lexical meaning of QIs and their interaction with the surrounding discourse? I will argue that QIs are characterized by the following three major properties. First, QIs have a hybrid semantics: they involve existential quantification over expressions, i.e. linguistic objects, but they make reference to both expressions and their denotations. This feature of QIs sets them apart from regular indefinites, which range over individuals. Second, QIs serve reportative functions. They range over quoted speech, i.e. pieces of language which originate with another speaker. This property is the source of the reportative implication mentioned above. Third, QIs impose restrictions on the type of expressions they range over. In this paper, I focus on QIs that express nominal categories, such as person or thing. Nominal QIs can only range over referential expressions, e.g. proper names, definite descriptions, or demonstratives, and not over quantificational or indefinite expressions. This is the reason why the QIs in (1)-(2) are understood as referring to specific individuals. I briefly illustrate how the proposed analysis can be extended to QIs which range over predicative expressions, e.g. adverbials.

Indefinite expressions with related meanings are attested in other languages as well. Sudo (2008) discusses the case of Japanese *wh*-doublets, e.g. *dare-dare*. He argues that such forms fill in for arbitrary person-denoting expressions and can only appear in quotation, as in (3). Japanese *wh*-doublets then differ from QIs in Bulgarian and German, whose distribution is by no means limited to quotational environments.

(3)   John-wa "Bill-ga   *dare-dare*-o   aishitieru" to itta.
      John-TOP "Bill-NOM who-who-ACC love"   C said
      'For some expression X such that X denotes a person, John said "Bill loves X".'

(Sudo 2008: 622)

QIs of the type found in Bulgarian and German are also akin to English placeholders like *what-shisface*, *whatshisname*, *so-and-so*, *such-and-such*, *thingummy*, *thingy*, *blah blah blah*, *yada yada*

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[3]Although the formulation of the reportative implication in (2) is absent in Cieschinger & Ebert's original translation, it closely follows their analysis.

yada, etc. Such illocutions fill in for linguistic expressions as well and very likely have an expression-based semantics. In addition, they can easily be understood as pointing at a previous conversation. For example, *whatshisface* in (4a) is most naturally interpreted as a placeholder for the name of the person Rebecca said she saw, and *yada yada yada* in (4b) fills in for various complaints one would hear from the newly megafamous.

(4)   a. Rebecca said she saw *whatshisface* last night.
      b. Becoming Headline News Refreshingly, you will not hear from Affleck the familiar complaints of the newly megafamous: the paparazzi, the zealous fans, lack of privacy, *yada yada yada*.   (*Cosmopolitan* 1999, vol. 226, iss. 4, pg. 204)

Unlike QIs in Bulgarian and German though, English placeholders can sometimes be used without reference to a previous conversation, as in (5).

(5)   a. Kate Middleton and Husband *Whatshisface* Get Baby George Christened
                                                                      (*Cosmopolitan*, October 23, 2013)
      b. I met this lawyer, we went out to dinner, I had the lobster bisque, we went back to my place, *yada yada yada*, I never heard from him again.   (*Seinfeld*, episode 147)

Some of the English placeholders listed above also differ from QIs in that they impose no restrictions on the type of the expression they refer to. While *whatshisface* stands for a proper name, *yada yada yada* can fill in for any stretch of discourse. English placeholders then match QIs in some but not all respects.

The structure of the paper is as follows. Section 2 discusses the core semantic properties of QIs, i.e. their indefiniteness, their reportativity, and the restrictions they impose on the expressions they range over. Section 3 presents the formal proposal, which is based on a simple two-dimensional semantics for quotation. Section 4 is the conclusion.

2. The data

2.1. Indefiniteness

QIs are intuitively felt to be indefinites rather than definites. Here I present two pieces of evidence in support of this intuition.[4] The first piece of evidence comes from the lack of uniqueness effects associated with QIs. According to an influential theory of (in)definiteness that goes back to Russell (1905), the use of definite descriptions requires a unique referent while the use of indefinite

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[4]See also Cieschinger & Ebert (2011) for evidence that German QIs exhibit the scopal properties of indefinites.

descriptions does not. The relevant contrast is illustrated for English in (6a), where in the given context only an indefinite description is felicitous. As demonstrated in (6b)-(6c), QIs in Bulgarian and German pattern with indefinites rather than definites in this respect.[5]

(6)   *Sarah has three boyfriends: Ryan, Brian, and Ian. She said tonight she would go out with one of them and mentioned his name but the speaker forgot it.*

    a.   Sarah said she will go out with #her boyfriend / a boyfriend.

    b.   Sara kaza, če šte izliza s   *edi-koe si* gadže.
       Sara say   that will go.out. with QI.NEUT boyfriend

       'Sarah said she will go out with a boyfriend.'

    c.   Sarah hat   gesagt, dass sie mit *dem und dem* Freund rausgehen wird.
       Sarah have.3SG say.PP that she with QI.DAT   friend go.out   will

       'Sarah said she will go out with a boyfriend.'

Second, like indefinites and unlike definites, QIs cannot refer back to a salient antecedent. Heim (1982) was among the first to point out that indefinites and definites differ in their discourse properties. In particular, while indefinites establish a new discourse referent, definites typically refer to a discourse referent that is already given. As seen from (7a), once a discourse referent is established, it can be referred back to by definites but not indefinites. Once again, QIs in Bulgarian (7b) and German (7c) exhibit the discourse properties of indefinites.

(7)   a.   A man^i walked in. Someone$_{\#i}$ / He$_i$ sat down.

    b.   Včera   govori-x s   Ivan^i. *Edi-koj si*$_{\#i}$ / Njakoj$_{\#i}$ / Čovek-ût$_i$ ima-l   nova
       yesterday talk-PAST with Ivan QI.MASC   / someone / guy-DEF   have-EV new
       rabota.
       job

       'Yesterday I talked to Ivan^i. The guy$_i$ has a new job.'

    c.   Ich habe   gestern   mit Claudia über ihren Bruder^i gesprochen. Sie hat
       I   have.1SG yesterday with Claudia about her   brother talk.PP   she have.3SG
       gesagt, *der und der*$_{\#i}$ / jemand$_{\#i}$ / er$_i$ hat   einen neuen Job.
       say.PP QI.MASC   / someone / he have.3SG a   new   job

       'Yesterday Claudia and I talked about her brother. She said he has a new job.'

These data lend strong support to the claim that QIs are indeed indefinites. This finding does not exhaust their indefinite meaning, though. I will argue below that QIs differ from regular indefinites in that they range over linguistic expressions. But for now we can view them as indefinite forms with some additional properties.

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    [5]I omit the reportative implication whenever its presence is irrelevant to the issue at hand.

2.2. Reportativity

By uttering a sentence with a QI the speaker indicates that she would normally be in a position to use a referential expression. The fact that she instead used a QI may suggest that the speaker forgot that expression or perhaps that she considers the identity of the referent to be irrelevant for the purposes of the conversation. To illustrate, the Bulgarian sentence in (1) above asserts that Maria is dating someone and further implies that Maria's date was mentioned to the speaker in a previous conversation, i.e. the conversation in which the speaker was told who Maria is dating. The reportative implication projects past entailment-canceling operators. It is not canceled when the sentence is negated or includes a modal operator.

(8) Maria ne / verojatno izliza-l-a   s   *edi-koj si*.
     Maria not / probably go.out-EV-FEM with QI.MASC

     'Maria is not/probably dating a certain person.'
     ⤳ 'Maria's date was mentioned to the speaker in a previous conversation.'

Cieschinger & Ebert (2011) analyze reportative implications triggered by QIs as presuppositions. This analysis nicely captures the projective behavior observed in (8). At the same time, such implications do not seem to be standard presuppositions. They typically introduce discourse-new information and are "informative" presuppositions at best (see Stalnaker 2002; Schlenker 2007; von Fintel 2008 on this notion). Also, the projection behavior of reportative implications is much unlike that of other presuppositions in at least two respects. First, reportative implications cannot be canceled the way other presuppositions can. While the simple sentence in (9a) presupposes that Jack has a wife, the sentence in (9b) does not, due to the fact that the presupposition of the main clause is entailed by the conditional antecedent. If we try to cancel the reportative implication in a similar way, we get infelicity, as seen from the Bulgarian sentence in (10).

(9) a. Jack's wife must be very patient.
     b. If Jack has a wife, then Jack's/his wife must be very patient.

(10) #Ako ču-ja   Maria s   kogo izliza, šte pokan-ja *edi-koj si*.
      if   hear-1SG Maria with whom go.out will invite-1SG QI.MASC

     'If I hear who Maria is dating, I will invite the guy.' (attempted)

Second, Karttunen (1974) notices that if the complement of an attitude predicate (which is not a factive verb or a verb of saying) presupposes p, then the sentence as a whole presupposes not p but rather that the attitude holder believes p (see also Heim 1992; Geurts 1999). Under normal circumstances, the sentence in (11) would presuppose not (11a) but rather (11b). This projection

pattern is not found in sentences with QIs, in which the reportative implication projects in its unmodified form (12).

(11)   Patrick wants to sell his cello.   (Heim 1992: 183)

    a.   ⤳̸ Patrick owns a cello.

    b.   ⤳ Patrick believes that he owns a cello.

(12)   Ivan iska-l   da se   obadi na *edi-koj si*.
    Ivan want-EV to REFL call   to QI.MASC

    'Ivan wants to call someone.'
    REPORTATIVE IMPLICATION:
    ✓ 'The person Ivan wants to call was mentioned to the speaker in a previous conversation.'
    ✗ 'Ivan believes that the person he wants to call was mentioned to the speaker in a previous conversation.'

The data in (10) and (12) come from Bulgarian but they can be replicated in German as well. It then appears that the reportative implication is systematically informative and projects in a stronger sense than standard presuppositions do. Given these findings, I will analyze it as a CONVENTIONAL IMPLICATURE, in the sense of Potts (2005), i.e. as a secondary entailment that projects.

It is clear from the above discussion that reportative implications make reference to a previous conversation. In other words, the interpretation of QIs depends on a secondary speech context. This predicts that QIs only occur in environments in which the existence of such context can be implied. Indeed, an out-of-the-blue utterance of the Bulgarian sentence in (13) would be infelicitous. QIs in this language need to be licensed either from inside the sentence, e.g. by a verb of saying in the matrix clause (14) or an indirect evidential marker in the host clause (see (1) above), or from previous discourse, as in (15).

(13)   #Iska-m   da gleda-m   *edi-koj si* film.
    want-1SG to watch-1SG QI.MASC movie

    'I want to see some movie.' (attempted)

(14)   Ivan kaza, če ima srešta s   *edi-koj si*.
    Ivan say   that have meeting with QI.MASC

    'Ivan said that he is meeting someone (he said who).'

(15)   Govori-x s   Ivan. Toj šte xodi do *edi-koj si* grad.
    talk-PAST with Ivan he   will go   to QI.MASC city

    'I talked to Ivan. He will visit some city (he said which one).'

Cieschinger & Ebert's (2011) discussion may give the impression that QIs in German need to be grammatically licensed by a c-commanding speech context operator. More specifically, German QIs are ruled out in simple main clauses (16) and typically appear in the scope of verbs of saying (see (2) and (6c) above), speech nouns like *Behauptung* 'claim', or evidential markers like *angeblich* 'allegedly'. However, licensing from discourse is sometimes possible, as (17) demonstrates.

(16)   Weißt   du was? #*Die und die* ist   von der Schule geflogen.
       know.3SG you what QI.MASC   be.3SG from the school fly.PP
       'Guess what. Someone has been expelled from school.' (attempted)

(17)   Ich habe gestern   mit Luise geredet und sie hat mir von ihrem Arbeitsalltag erzählt.
       I   have yesterday with Luise spoken and she has me of   her   work routine told
       Der und der lässt   immer die Fenster   offen, *die und die* setzt nie   neuen Kaffee auf
       the and the leaves always the windows open   the and the puts never new   coffee on
       und *der und der* kommt immer zu spät.
       and the and the comes always too late
       'I spoke to Luise yesterday and she told me about her work routine. Someone [...] always leaves the windows open, someone else [...] never brews new coffee, and someone else [...] is always late.'   (Cieschinger & Ebert 2011: 196)

I will then adopt the view that QIs in Bulgarian and German can be licensed by grammar or discourse, assuming that their use is acceptable as long as the existence of a secondary speech context can be implied.

The final facet of reportativity that I discuss concerns quotation. When they appear in direct quotation, QIs are ambiguous between a reading whereby they lose their semantic properties (just like other quoted material) and a reading whereby their semantic properties are retained. To illustrate, the Bulgarian sentence in (18) is ambiguous between a VERBATIM reading, in which the speaker repeats Ivan's exact words, and a NON-VERBATIM reading, in which the QI fills in for a (referential) description contained in the original utterance. Parallel sentences in German give rise to the same two readings, see (19). As Clark & Gerrig (1990) already notice on the basis of similar examples, the same ambiguity is found with English placeholders (20).

(18)   Ivan kaza: "Maria izliza-l-a   s   *edi-koj si*".
       Ivan say: "Maria go.out-EV-FEM with QI.MASC"

   a. 'Ivan said: "Maria izlizala s edi-koj si".'   (verbatim reading)

   b. 'Ivan said: "Maria izlizala s z", for some referential expression z.'
                                                                          (non-verbatim reading)

(19) Claudia sag-te: "*Der und der* ist   angeblich von der Schule geflogen".
      Claudia say-PAST: "QI.MASC   be.3SG allegedly from the school fly.PP"

   a. 'Claudia said: "Der und der ist angeblich von der Schule geflogen".'

                                                                                (verbatim reading)

   b. 'Claudia said: "*z* ist angeblich von der Schule geflogen", for some referential expres-
       sion *z*.'   (non-verbatim reading)

(20) Kyle said: "I haven't seen *whatshisface* in a while".

   a. 'Kyle said: "I haven't seen whatshisface in a while".'   (verbatim reading)

   b. 'Kyle said: "I haven't seen *z* in a while", for some proper name *z*.'

                                                                           (non-verbatim reading)

One might wonder whether there are cues that disambiguate between the two possible interpreta-
tions of such sentences. Indeed, the absence of a reportative operator inside the quotation provides
one such cue. The quotations in (18)-(19) contain reportative operators (*-l* '-EV' or *angeblich*
'allegedly', respectively), which license yet do not require a QI. The quoted segment is thus am-
biguous: it could have been uttered as is (the verbatim interpretation) or with some expression
occurring in lieu of the QI (the non-verbatim interpretation). However, the non-verbatim reading
seems to disappear as soon as the reportative operator is removed because in that case it is much
harder to construe the quoted segment as uttered in isolation.

The availability of non-verbatim readings suggests that QIs can "confuse" mention and use. I take
this to be a first indication of the fact that QIs have a mixed expression/denotation-based semantics.
This idea will be one of the major stepping stones for the formal analysis in Section 3.

2.3. Restrictions on expressions

I indicated above that QIs range over pieces of language that the speaker heard in a previous
conversation. Not just any expression can serve as a QI "antecedent", though. Such expressions
need to be REFERENTIAL terms, e.g. a proper name, a definite description, or a demonstrative, as
in (21). They cannot be quantificational DPs (22).

(21) *Maria*: Ima-m   srešta   s   Ivan / šef-a   mi / tozi čovek.
              have-1SG meeting with Ivan / boss-DEF my / this guy

              'I am meeting with Ivan / my boss / this guy.'

      Speaker: Maria ima-l-a   srešta   s   *edi-koj si*.
                  Maria have-EV-FEM meeting with QI.MASC

                  'Maria is meeting with someone.'

(22) *Maria*: Ima-m   srešta   s   mnogo koleg-i   / vsički deca.
       have-1SG meeting with many   colleague-PL / all   child.PL
       'I am meeting with many coworkers / all the kids.'

    Speaker: #Maria ima-l-a   srešta   s   *edi-koi si* koleg-i   / *edi-koi si* deca.
       Maria   have-EV-FEM meeting with QI.PL   colleague-PL / QI.PL   child.PL

It should be emphasized that the restrictions imposed by QIs are indeed on expressions rather than individuals. In (21), for example, the speaker may not have been able to identify the person Maria had referred to in the source context. Even so, the fact that the speaker knows Maria used a referential term is enough to license a report with a QI.

The "antecedent" expression cannot be an indefinite, not even a SPECIFIC indefinite, as visible from (23).

(23) *Ivan*: Sreštna-x   edin prijatel ot   učilište.
      meet-PAST one   friend   from school
      'I met a friend of mine from school.'

    Speaker: #Ivan sreštna-l *edi-koj si* prijatel ot   učilište.
      Ivan   meet-EV QI.MASC friend   from school

This finding might be initially striking, as specific indefinites have sometimes been analyzed as referential expressions (see e.g. Fodor & Sag 1982). If so, the impossibility of QIs to range over specific indefinites, which in context can be understood as referring to specific individuals, could be taken as further evidence that QIs impose restrictions not on regular model-theoretic entities but rather on linguistic expressions.

The Bulgarian data in (21)-(23) echo similar restrictions on antecedents imposed by QIs in German. Cieschinger & Ebert (2011: 177–178) notice that (24a), which includes referential expressions, but not (24b), which uses indefinites, can be the source of (25).

(24) *a. Luise*: Der Student aus   München / Ludwig hat schon wieder das Fenster   offen
       the   student from Munich   / Ludwig has   yet   again   the   window open
    gelassen.
    left
    'The student from Munich / Ludwig has left the window open yet again.'

    b. Luise: Irgendjemand / Ein Freund von mir   aus   München hat schon wieder das
       someone   / a   friend   of   mine from Munich   has   yet   again   the
    Fenster   offen gelassen.
    window open   left

'Someone/A friend of mine from Munich has left the window open yet again.'

(25) *Speaker*: Luise hat sich   mal wieder beklagt,   *der und der* hätte   schon
                 Luise has [REFL] yet again complained the and the would.have yet
      wieder das Fenster offen gelassen.
      again   the window open left
      'Luise complained again that someone has left the window open yet again.'

These data suggest that the referentiality restriction on "antecedent" expressions is quite robust
across Bulgarian and German.

3. Proposal

The formal account rests on the assumption that QIs range over referential expressions that origi-
nate in a previous conversation. The intuitive idea is that QIs are placeholders for quoted material.
Since quotation plays such an important role, the formal account of QIs will be embedded into a
semantics for quotation.

3.1. A two-dimensional semantics for quotation

The semantics of quotation has been extensively studied in the philosophy and formal semantics
literature (see Potts 2007; Shan 2010; Ginzburg & Cooper 2014; Maier 2014; see also Cappelen &
Lepore 2012 and Saka 2013 for two recent overviews). In this section, I build on the main insights
coming from previous work and introduce a two-dimensional semantics for quotation on which the
analysis of QIs is based.

When analyzing quotation, the first and perhaps most important move is to ensure that linguis-
tic expressions are recognized as model-theoretic entities in their own right. To this end, I follow
Potts (2007) and introduce a logical type for linguistic expressions. I assume the basic types e
(for individuals), t (for truth values), s (for possible worlds), k (for speech contexts), and u for
linguistic expressions. Complex types are formed from these and can be functional (e.g. $\sigma \to \tau$)
or product (e.g. $\sigma \times \tau$), for any types σ and τ. Product types are assigned to two-dimensional
meanings. I assume domains for all basic entities as well as functional and product domains, de-
fined as $D_{\sigma \to \tau} := D_\tau^{D_\sigma}$ and $D_{\sigma \times \tau} := D_\sigma \times D_\tau$ (respectively). The full domain is defined as
$D := \bigcup_{\tau \in Type} D_\tau$. Domains of the form D_u are sets of all possible strings, not only the ones that
are a part of the language. This is because quoted speech need not be well-formed.

We saw in Section 2.2 that sentences with QIs give rise to reportative implications which behave
like conventional implicatures. In order to capture this fact, I will assume that meanings in general

are two-dimensional, such that truth-conditional content makes up the first dimension and conventionally implicated content projects a second dimension (cf. Potts 2005; 2007). A two-dimensional semantics like this necessitates a slight reformulation of the standard composition rule of function application along the following lines.

(26) TWO-DIMENSIONAL FUNCTION APPLICATION
If $[\![A]\!]^{c,w}_{(\sigma\to\tau)\times t} = \langle a_1, a_2 \rangle$ and $[\![B]\!]^{c,w}_{\sigma\times t} = \langle b_1, b_2 \rangle$, then $[\![A\,B]\!]^{c,w}_{\tau\times t} = [\![B\,A]\!]^{c,w}_{\tau\times t} = \langle a_1(b_1), a_2 \,\&\, b_2 \rangle$.

This rule states that function-argument composition happens in the first dimension while conventionally implicated content is simply conjoined. Since the latter content is always of type t, conjoining it is always possible. For example, let $[\![\text{Kristen}]\!]^{c,w}_{e\times t} = \langle \mathbf{kristen}, \top \rangle$ and $[\![\text{asleep}]\!]^{c,w}_{(e\to t)\times t} = \langle \lambda x_e.\mathbf{asleep}(w, x), \top \rangle$, where c is a context, w is a possible world, and lexical items without conventionally implicated content are assigned $\top$ (for "tautology") in their second dimension. These two meanings can be composed by the rule in (26) to $[\![\text{Kristen is asleep}]\!]^{c,w} = \langle \mathbf{asleep}(w, \mathbf{kristen}), \top \rangle$, which asserts that Kristen is asleep (in the world w and the context c) and has an uninformative second meaning dimension. Also, we can assume that sentential operators only take scope over the first, truth-conditional dimension while the second meaning dimension projects. For example, if we define negation as $[\![\text{not}]\!]^{c,w}_{(t\to t)\times t} = \langle \lambda p_t.\neg p, \top \rangle$, we get $[\![\text{not [Kristen is asleep]}]\!]^{c,w} = \langle \neg\mathbf{asleep}(w, \mathbf{kristen}), \top \rangle$.

Next, I discuss quotation and demonstrate how its core semantic properties can be captured in the formal setup just outlined. Quotation is often subdivided into three major categories: PURE, DIRECT, and MIXED.

(27) a. "Bachelor" has eight letters.   (pure quotation)
b. Quine said: "Quotation has a certain anomalous feature".   (direct quotation)
c. Quine said that quotation "has a certain anomalous feature".   (mixed quotation)

Pure quotation is a linguistic tool which enables speakers to make reference not to the denotation of an expression but rather to the expression itself. Direct quotation makes reference to expressions as well but it also attributes the quoted segment to another speaker. Mixed quotation owes its name to the fact that it exhibits a mixture of properties associated with both direct and indirect discourse (see Davidson 1979; Cappelen & Lepore 1997; Potts 2007; Shan 2010; Maier 2014). Like indirect discourse, mixed quoted segments contribute to the semantic composition in the usual way. However, and similar to direct quotation, such segments attribute the quoted expression to another speaker.

I assume that direct and pure quotations share core semantic properties.[6] They both contribute an expression rather than a regular meaning to the semantic computation (cf. the so-called DIS-QUOTATIONAL THEORY of quotation, first proposed in Richard 1986). In addition, they both fill argument positions, as can be seen from (27a)-(27b) (see also Partee 1973; Recanati 2001; Bonami & Godard 2008; de Vries 2008). As a first pass, I propose the following interpretation rule for pure/direct quotation. (I use Quine corners $\ulcorner \cdot \urcorner$ in the metalanguage to reference a string.)

(28)   PURE/DIRECT QUOTATION (first version)
$$[\![``\alpha"]\!]^{c,w}_{u \times t} = \langle \ulcorner \alpha \urcorner, \top \rangle$$

I assume that mixed quotations contribute the regular meaning of the quoted expression and conventionally implicate that the quoted segment was uttered in a previous conversation.[7] An interpretation rule for mixed quotation that achieves this effect is given below. For a given speech context c, let $\mathbf{sp}(c)$ be the speaker of c, $\mathbf{hr}(c)$ be the hearer of c, and $\mathbf{utt}(c)$ be the set of expressions uttered in c.

(29)   MIXED QUOTATION
$$[\![``\alpha"]\!]^{c,w}_{\sigma \times t} = \left\langle \begin{array}{c} [\![\alpha]\!]^{c',w}, \\ \mathbf{sp}(c) = \mathbf{hr}(c') \ \& \ \ulcorner \alpha \urcorner \in \mathbf{utt}(c') \end{array} \right\rangle, \text{for any type } \sigma$$

This interpretation rule states that a mixed quoted segment is interpreted relative to a source context c', thus capturing the fact that indexical elements inside mixed quotation usually undergo perspective shift (see Maier 2014). Mixed quotation conventionally implicates that the quoted segment was uttered in the source context and that the current speaker participated in that context as a hearer. I assume that the free metalanguage variable c' is bound from previous discourse, which supplies a source context. For example, in *Trump said that McCain is "not a war hero"* the source context will be understood as the secondary context introduced by the verb of saying.

This semantics for quotation leaves out several intricate aspects (see Partee 1973; Recanati 2001; Potts 2007; Shan 2010; Ginzburg & Cooper 2014; Maier 2014; a.o.). However, it is enough to provide a basis for the analysis of QIs and the way they interact with quoted and non-quoted speech. This is the task I turn to in the next section.

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[6]Following Ginzburg & Cooper (2014), one could propose that pure quotations make a statement about utterance types and thus generalize direct quotations, which make a statement about utterance tokens.

[7]I treat secondary implications introduced by mixed quotations as conventional implicatures (cf. Potts 2007) rather than presuppositions (see Maier 2014) mainly because they impose no preconditions on the common ground. What the common ground needs to supply is a source context for the quoted segment, not entail the implication.

3.2. Factoring in QIs

Let me recap the semantic properties of QIs in Bulgarian and German.

(i) QIs have a mixed semantics. They make reference to both expressions and their denotations.

(ii) QIs serve reportative functions. They require that the expressions they existentially quantify over be uttered in a previous conversation.

(iii) QIs impose restrictions on the type of expressions they range over. Nominal QIs, which are the focus of this paper, can only range over referential expressions.

I propose the following lexical meaning for QIs.[8]

(30) QUOTATIONAL INDEFINITES
$$[\![\text{QI}]\!]^{c,w}_{((e \to t) \to t) \times t} = \left\langle \begin{array}{c} \lambda P_{e \to t}.\exists z_u P([\![z]\!]^{c',w}), \\ \mathbf{sp}(c) = \mathbf{hr}(c') \, \& \, z \in \mathbf{utt}(c') \, \& \, \mathbf{r\text{-}expr}(w,z) \end{array} \right\rangle$$

According to this definition, QI meanings are truly two-dimensional. In their truth-conditional component, QIs compose with the rest of the sentence in the same way regular indefinites do. However, QIs range over expressions and conventionally implicate various restrictions on such expressions, i.e. that they are referential and that they were uttered in a conversation in which the current speaker participated as a hearer. The proposed meaning then directly derives the properties of QIs listed in (i)-(iii) above.

Notice that there are free occurrences of two metalanguage variables in (30). The expression z is introduced in the first meaning dimension but is free in the second meaning dimension. The source context c' is free throughout. I assume that the former variable is bound by the existential quantifier in the first dimension and that the latter variable is bound from previous discourse (just like in the case of mixed quotation). Although the proposed static semantics cannot make such discourse anaphoric dependencies formally explicit, these dependencies are naturally captured in dynamic systems that separate the primary and the secondary entailments of the sentence (see Nouwen 2007; Koev 2013; AnderBois et al. 2015).

Also, one should not miss the close similarity between (30) and the proposed meaning for mixed quotation in (29). Both meanings give rise to reportative implications, although mixed quotations

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[8]I disregard the fact that QIs in Bulgarian and German can optionally take an NP complement, as in *edi-koj si student* or *der und der Student* 'QI.MASC student'. If a restrictor argument is indeed obligatory, the truth-conditional meaning of QIs should be amended to $\lambda P_{e \to t} \lambda Q_{e \to t}.\exists z_u (P([\![z]\!]^{c',w}) \, \& \, Q([\![z]\!]^{c',w}))$. One could then assume that when an overt restrictor is missing, a covert NP with some underspecified meaning is present.

refer to a specific expression while QIs existentially quantify over expressions. In other words, QIs can be viewed as existential generalizations over quoted expressions. This consequence of the analysis does justice to the intuition that *Maria is dating QI* can be understood as a less informative counterpart of *Maria is dating "her boss"*.

I now derive the readings of QIs when they occur in quoted and non-quoted environments. Starting off with non-quoted environments, I assume that when QIs are syntactic arguments of predicates they undergo QUANTIFIER RAISING, i.e. they covertly adjoin to the host clause and their argument slot is lambda bound (see May 1977; Heim & Kratzer 1998). I assume that the lambda-abstracted predicate, which composes with the raised QI, is interpreted by the following predicate abstraction rule.

(31)   TWO-DIMENSIONAL PREDICATE ABSTRACTION
       If $[\![S]\!]_{t \times t}^{c,w,g} = \langle [\![S_1]\!]^{c,w,g}, [\![S_2]\!]^{c,w,g} \rangle$, then $[\![i\ S]\!]_{(e \to t) \times t}^{c,w,g} = \langle \lambda x_e.[\![S_1]\!]^{c,w,g[t_i/x]}, [\![S_2]\!]^{c,w,g} \rangle$.

As an illustration, consider the compositional interpretation of the Bulgarian clause *Maria xaresva edi-koj si* 'Maria likes QI'. The second line in (32b) makes use of the predicate abstraction rule in (31).

(32)   a. edi-koj si [1 [Maria xaresva t_1]]
       b. $[\![\text{Maria xaresva } t_1]\!]^{c,w,g} = \langle \mathbf{like}(w, \mathbf{maria}, g(t_1)), \top \rangle$
          $[\![\text{1 [Maria xaresva } t_1]]\!]^{c,w,g} = \langle \lambda x_e.\mathbf{like}(w, \mathbf{maria}, x), \top \rangle$
          $[\![\text{edi-koj si [1 [Maria xaresva } t_1]]]\!]^{c,w,g}$
          $= \left\langle \begin{array}{c} \exists z_u \mathbf{like}(w, \mathbf{maria}, [\![z]\!]^{c',w,g}), \\ \mathbf{sp}(c) = \mathbf{hr}(c') \,\&\, z \in \mathbf{utt}(c') \,\&\, \mathbf{r\text{-}expr}(w, z) \end{array} \right\rangle$

The resulting meaning asserts that Maria likes someone and conventionally implicates that the speaker heard a referential expression denoting that person in another speech context. This meaning will only be acceptable if embedded in a discourse which implies a secondary speech context that can be picked out by c'. For example, this could be the context introduced by verbs of indirect speech, which I assume have denotations along the following lines (cf. Kaplan 1989; Sæbø 2013).

(33) $[\![\text{say } S]\!]_{(e \to t) \times t}^{c,w} = \langle \lambda x_e.\exists c'_k \exists S'_u (S' \in \mathbf{utt}(c') \,\&\, x = \mathbf{sp}(c') \,\&\, [\![S']\!]^{c'} \subseteq [\![S]\!]^c), \top \rangle$

According to this interpretation rule, a sentence of the form A *said that* S requires that A uttered some expression S' which (as interpreted in the source context) entails S (as interpreted in the utterance context). The entailment condition is formally stated as $[\![S']\!]^{c'} \subseteq [\![S]\!]^c$, where $[\![\alpha]\!]^c$, with

the world argument suppressed, is the INTENSION of α in a context c, i.e. a function from possible worlds w to $[\![\alpha]\!]^{c,w}$.[9]

With this meaning in place, the interpretation of (34a) will be as in (34b). This interpretation asserts that Ivan's original utterance entails that Maria likes someone and conventionally implicates that Ivan used a referential expression to pick out that person. The derived meaning is fully in line with intuitions about the meaning of (34a).

(34)   a. Ivan kaza, če   Maria xaresva *edi-koj si*.
            Ivan say   that Maria like   QI.MASC
        b. $[\![\text{Ivan kaza edi-koj si [1 [Maria xaresva } t_1]]]\!]^{c,w}$
            $= \left\langle \begin{array}{c} \exists c'_k \exists S'_u(S' \in \mathbf{utt}(c') \,\&\, \mathbf{ivan} = \mathbf{sp}(c') \,\&\, [\![S']\!]^{c'} \subseteq \lambda w'_s.\exists z_u \mathbf{like}(w', \mathbf{maria}, [\![z]\!]^{c',w})), \\ \mathbf{sp}(c) = \mathbf{hr}(c') \,\&\, z \in \mathbf{utt}(c') \,\&\, \mathbf{r\text{-}expr}(w, z) \end{array} \right\rangle$

Next, I discuss the readings of QIs in pure/direct quotation. Recall from (18) that in such cases QIs can be interpreted as part of the quotation (the verbatim reading) or as filling in for some referential expression present in the original utterance (the non-verbatim reading). The verbatim reading of (18) follows if we assume that direct speech verbs have lexical meanings as in (35) and make use of the interpretation rule for pure/direct quotations in (28).

(35) $[\![\text{say: "}S\text{"}]\!]^{c,w} = \langle \lambda x_e. \exists c'_k([\![\text{"}S\text{"}]\!]^{c,w} \in \mathbf{utt}(c') \,\&\, x = \mathbf{sp}(c')), \top \rangle$

(36) $[\![\text{Ivan kaza: "Maria izlizala s edi-koj si"}]\!]^{c,w}$
        $= \langle \exists c'_k(\ulcorner\text{Maria izlizala s edi-koj si}\urcorner \in \mathbf{utt}(c') \,\&\, \mathbf{ivan} = \mathbf{sp}(c')), \top \rangle$

In order to derive the non-verbatim reading of (18), I assume that QIs can raise out of quotation (cf. Sudo 2008; Maier 2014). Since syntactic movement out of quotation is generally prohibited, I hypothesize that it is possible for QIs because of their expression-based semantics. This assumption necessitates a way to handle traces inside quotation, which requires a slight reformulation of the original interpretation rule for pure/direct quotation in (28). The final version of the rule allows traces inside quotation to be substituted by other expressions without interpreting the quotation itself.

(37)   PURE/DIRECT QUOTATION (final version)
        $[\![\text{"}\alpha\text{"}]\!]_{u \times t}^{c,w,g[t_1/[\![z_1]\!]^{c',w,g},...,t_n/[\![z_n]\!]^{c',w,g}]} = \langle \ulcorner\alpha\urcorner[t_1/z_1, ..., t_n/z_n], \top \rangle,$

---

[9]I am slightly abusing notation here. Since intensions are functions rather than sets, the entailment condition should rather read $\forall w'([\![S']\!]^{c'}(w') \Rightarrow [\![S]\!]^{c}(w'))$. Alternatively, the entailment condition could be written as $^{\{\}}[\![S']\!]^{c'} \subseteq {}^{\{\}}[\![S]\!]^{c}$, where $^{\{\}}\varphi_{s \to t} := \{w \in D_s \mid \varphi(w) = 1\}$.

where $\ulcorner\alpha\urcorner[t_1/z_1, ..., t_n/z_n]$ is just like $\ulcorner\alpha\urcorner$ but with all occurrences of $t_1, ..., t_n$ in $\ulcorner\alpha\urcorner$ substituted by $z_1, ..., z_n$ (respectively)

The non-verbatim reading of (18) can now be derived as shown, where the pure/direct quotation rule is employed in the last step of the derivation. The meaning we arrive at correctly states that Ivan uttered the words "Maria izlizala s z", where z is some referential expression.

(38) $[\![\text{edi-koj si } [1 \text{ [Ivan kaza: "Maria izlizala s } t_1\text{"]]}]\!]^{c,w,g}$
$$= \left\langle \begin{array}{c} \lambda P_{e\to t}.\exists z_u P([\![z]\!]^{c',w,g})(\lambda x_e.\exists c'_k([\![\text{"Maria izlizala s } t_1\text{"}]\!]^{c,w,g[t_1/x]} \in \mathbf{utt}(c') \,\&\, \mathbf{ivan} = \mathbf{sp}(c'))), \\ \mathbf{sp}(c) = \mathbf{hr}(c') \,\&\, z \in \mathbf{utt}(c') \,\&\, \mathbf{r\text{-}expr}(w, z) \,\&\, \top \end{array} \right\rangle$$
$$= \left\langle \begin{array}{c} \exists z_u \exists c'_k([\![\text{"Maria izlizala s } t_1\text{"}]\!]^{c,w,g[t_1/[\![z]\!]^{c',w,g}]} \in \mathbf{utt}(c') \,\&\, \mathbf{ivan} = \mathbf{sp}(c')), \\ \mathbf{sp}(c) = \mathbf{hr}(c') \,\&\, z \in \mathbf{utt}(c') \,\&\, \mathbf{r\text{-}expr}(w, z) \end{array} \right\rangle$$
$$= \left\langle \begin{array}{c} \exists z_u \exists c'_k(\ulcorner\text{Maria izlizala s } z\urcorner \in \mathbf{utt}(c') \,\&\, \mathbf{ivan} = \mathbf{sp}(c')), \\ \mathbf{sp}(c) = \mathbf{hr}(c') \,\&\, z \in \mathbf{utt}(c') \,\&\, \mathbf{r\text{-}expr}(w, z) \end{array} \right\rangle$$

3.3. Predicative QIs

The discussion so far has focused on QIs which range over nominal expressions. However, QIs are a much more diverse class and can range over various predicative expressions. For example, Bulgarian indefinites of the *edi-* series include forms like *edi-koga si* 'sometime' and *edi-kûde si* 'somewhere' and German has QI forms like *dann und dann* 'sometime' and *da und da* 'somewhere', which range over time or place adverbials. The formal account easily extends to predicative QIs as well. We only need to modify the truth-conditional component and impose appropriate restrictions on the expressions quantified over. Below, I state a plausible lexical meaning for Bulgarian *edi-kak si* 'somehow', which ranges over manner adverbials. (I assume that that ε is the logical type of events.)

(39) $[\![\text{edi-kak si}]\!]^{c,w}_{(\varepsilon\to t)\times t} = \left\langle \begin{array}{c} \lambda e_\varepsilon.\exists Z_u[\![Z]\!]^{c',w}(e), \\ \mathbf{sp}(c) = \mathbf{hr}(c') \,\&\, Z \in \mathbf{utt}(c') \,\&\, \mathbf{manner\text{-}adv}(w, Z) \end{array} \right\rangle$

According to (39), *edi-kak si* is a predicate of events. The requirement that it existentially quantifies over manner adverbials is directly stated in the second meaning dimension. A sentence as in (40a), when uttered in a context c and world w, will be assigned the meaning in (40b).

(40)   a. Ivan bjaga-l *edi-kak si*.
            Ivan run-EV QI
            'Ivan runs/ran in some previously mentioned manner.'

b. $\left\langle \begin{array}{l} \exists e_\varepsilon \exists Z_u(\mathbf{run}(e) \,\&\, \mathbf{agent}(e) = \mathbf{ivan} \,\&\, [\![Z]\!]^{c',w}(e)), \\ \mathbf{sp}(c) = \mathbf{hr}(c') \,\&\, Z \in \mathbf{utt}(c') \,\&\, \mathbf{manner\text{-}adv}(w, Z) \end{array} \right\rangle$

Other predicative QIs can be analyzed in a similar way.

4. Conclusion

I have argued that QIs range over quoted speech and that this explains their semantic properties. More specifically, I claimed (i) that QIs range over linguistic expressions and make reference to both expressions and their denotations, (ii) that QIs require that the expressions they existentially quantify over are uttered in a previous conversation, and (iii) that QIs impose specific restrictions on the type of expressions they range over. The formal proposal was able to derive all of these properties. By adopting a logical type for linguistic expressions, we were able to account for the readings of QIs both inside and outside quotation.

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On the semantics of *wh*-questions[1]

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Abstract. This paper develops a new framework for the syntax and semantics of interrogative constructions which unifies the mechanisms of scope-taking employed in *wh*-movement, *wh*-in-situ, and partial *wh*-movement constructions. This framework represents the first major account for a wide range of syntactic and semantic facts relating to the structure and meaning of interrogatives at the same time, including pied-piping, superiority, presuppositions of questions, readings of multiple questions (single-pair vs pair-list), and intervention effects in multiple questions. It thus achieves a wider empirical coverage than other theories of interrogative syntax-semantics (e.g. Hamblin, 1973; Karttunen, 1977; Hagstrom, 1998; Cable, 2007, 2010; Cheng and Demirdache, 2010; Fox, 2012; Nicolae, 2013), and is at the same time simpler than these other proposals.

1. Introduction

The syntax/semantics literature offers two approaches to the interpretation of in-situ *wh*-phrases in questions: they may be interpreted at C via covert movement (Karttunen, 1977: a.o.), (1a), or in their base positions via an in-situ mode of composition (Hamblin, 1973: a.o.), (1b):[2]

(1) **Two possible analyses of *wh*-in-situ in English multiple questions:**
Which student did Mary introduce to *which* professor?
a. LF: *Which* student *which* professor C did Mary introduce ____ to ____?[3]

b. LF: *Which* student C did Mary introduce ____ to *which* professor ?

This paper sketches a new framework for the syntax and semantics of *wh*-questions. The proposal builds on the syntactic proposals for *wh*-movement and pied-piping in Pesetsky (2000) and Cable (2007, 2010) and develops a new and simple semantics that combines ingredients familiar from the literature in a novel way. This syntax-semantics is able to combine with Beck's (2006) theory of *intervention effects*, and it is able to explain the distribution of readings of so-called quiz-master readings and of nested *which*-phrases.

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[2]Here and throughout, I use straight arrows to indicate movement and curly arrows to indicate areas in which Rooth-Hamblin alternatives are computed. These curly arrows are used here for notational convenience only. Dashed arrows indicate covert movement.

[3]I illustrate covert movement with tucking in (Richards, 1997). This will become important later, in order to correctly derive the presuppositions of multiple questions.

2. Background

2.1. Questions, multiple questions, and superiority effects

The formation of a simplex *wh*-question in English involves at least two steps. First, a structure is formed in which a *wh*-phrase is introduced as an argument or adjunct. Second, this *wh*-phrase is fronted to the left edge of the sentence.[4]

(2) **English simplex questions require *wh*-fronting:**
     Which book did John read ____?

In a multiple question, only one *wh*-phrase is fronted, with additional *wh*-phrases pronounced in their base-generated positions. In questions with two D-linked *wh*-phrases, two word-orders are possible in multiple questions. In *superiority-obeying* questions, the base-generated higher *wh*-phrase is overtly fronted. In *superiority-violating* questions, the base-generated lower *wh*-phrase is fronted over the higher one.

(3) **English multiple questions allow either *wh* to front:**
     a. *Which* student ____ read *which* book?   superiority-obeying
     b. *Which* book did *which* student read ____?   superiority-violating

Based on syntactic considerations, as well as evidence from intervention effects and licensing of Antecedent Contained Deletion, different underlying structures have been proposed for superiority-obeying and superiority-violating questions in the literature (Pesetsky, 2000; Beck, 2006; Cable, 2007, 2010; Kotek, 2014). Superiority-obeying questions are argued to involve covert movement of the (phonologically) in-situ *wh*-phrase (4a), whereas in superiority-violating questions, the surface in-situ *wh*-phrase is argued to be truly in-situ at LF (4b).

(4) **Different syntactic assumptions for obeying and violating questions:**
     a. *Which* student *which* book C ____ read ____?   (= 3a)

     b. *Which* book C did *which* student read ____?   (= 3b)

A pronunciation rule is responsible for producing the correct word order for the structure in (4a): the *wh* occupying the highest Spec,CP is pronounced at the head of its chain, and all other *wh*s are pronounced at the tail of their chains (see Pesetsky 2000; Cable 2010).[5]

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[4]Here we set aside T-to-C movement, which is irrelevant for the purposes of this paper.

[5]The requirement to have one *wh*-phrase pronounced in Spec,CP is attributed here to C's EPP feature.

2.2. The readings of multiple questions

The literature recognizes three distinct readings of multiple *wh*-questions: the pair-list, single-pair, and echo-question readings (Wachowicz, 1974; Pope, 1976; Bolinger, 1978; Comorovski, 1989; Dayal, 1996: a.o.).[6] In this paper I will concentrate on the first two readings, and will not discuss the latter. For illustration, I use a context with three students, John, Mary, Bill and three books, Moby Dick, War and Peace, Oliver Twist.

(5) **Two readings of multiple questions:**
Which student read *which* book?
   a. <u>Single-pair</u>: *John read Moby Dick*.
   b. <u>Pair-list</u>: *John read Moby Dick, Mary read War & Peace, and Bill read Oliver Twist*.

The single-pair reading is felicitous just in case the asker presupposes that a single student-book pair satisfies the proposition that some student read some book. The pair-list reading, on the other hand, involves answering a set of questions. For each individual in the domain of *student*, we ask: which book did that individual read?

(6) **A set of *which book* questions ranging over students:**
Which student read *which* book?
$$\left\{ \begin{array}{l} \text{Which book did John read?} \\ \text{Which book did Mary read?} \\ \text{Which book did Bill read?} \end{array} \right\}$$

On this reading, the question invites the addressee to list all the relevant pairs in the context. Assuming that the meaning of a question is the set of possible answers to the question (Hamblin, 1973; Karttunen, 1977), spelling out the denotation of each question in the set in (6) yields a family of questions "sorted" by the higher *wh*, here *students* (Roberts, 1996; Hagstrom, 1998; Krifka, 2001; Büring, 2003; Willis, 2008; Fox, 2012; Nicolae, 2013; Constant, 2014: a.o.):

(7) **A family of questions denotation for the superiority-obeying question in (5/6):**
$$\left\{ \left\{ \begin{array}{l} \text{John read MD} \\ \text{John read WP} \\ \text{John read OT} \end{array} \right\}, \left\{ \begin{array}{l} \text{Mary read MD} \\ \text{Mary read WP} \\ \text{Mary read OT} \end{array} \right\}, \left\{ \begin{array}{l} \text{Bill read MD} \\ \text{Bill read WP} \\ \text{Bill read OT} \end{array} \right\} \right\}$$

A similar procedure can be employed for the interpretation of a superiority-violating question. Intuitively, such a multiple question is different from its superiority-obeying counterpart—it asks for a comprehensive list of readers for each book in the domain (whereas the superiority-obeying

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[6]At first blush, one might imagine that the single-pair is a special case of the pair-list reading, appropriate in a context that supports exactly one pair as a possible answer. However, there are reasons to think that that is not the case. In particular, we find cases in which the pair-list reading of the question is possible, but the single-pair reading is not. Such cases are exemplified in Wiltschko (1997), and discussed in greater detail in Kotek (2014: §6.5).

question asks for a list of books read by each person in the domain). Evidence for this difference comes from presuppositions, as will be discussed below. In this case, then, we construct a set of questions about the books in the domain:

(8) **A set of questions for the superiority-violating question:**
Which book did *which* student read?
$$\left\{ \begin{array}{l} \text{Which student read Moby Dick?} \\ \text{Which student read War and Peace?} \\ \text{Which student read Oliver Twist?} \end{array} \right\}$$

Spelling out the meaning of each question, using the same procedure as for the superiority-obeying question above, yields now a family of questions sorted by *books*:

(9) **A family of questions denotation for a superiority-violating question:**
Which book did *which* student read?
$$\left\{ \left\{ \begin{array}{l} \text{John read MD} \\ \text{Mary read MD} \\ \text{Bill read MD} \end{array} \right\}, \left\{ \begin{array}{l} \text{John read WP} \\ \text{Mary read WP} \\ \text{Bill read WP} \end{array} \right\}, \left\{ \begin{array}{l} \text{John read OT} \\ \text{Mary read OT} \\ \text{Bill read OT} \end{array} \right\} \right\}$$

Notice that the set in (7) ensures that each person read a book, but there may be books that no one read; and the set in (9) ensures that each book was read by someone, but there may be individuals who did not read any book. In contrast to the nested structure of pair-list readings, the single-pair reading of the question can be modeled as a simple question: itself a 'flat' set of propositions without internal structure:

(10) **A single-pair reading is modeled as a set of propositions:**
$$\left\{ \begin{array}{l} \text{John read MD, John read WP, John read OT, Mary read MD,} \\ \text{Mary read WP, Mary read OT, Bill read MD, Bill read WP, Bill read OT} \end{array} \right\}$$

The denotations of superiority-obeying and superiority-violating questions are thus distinct in terms of the structure of their possible answer sets. These differences are motivated by differences in the presuppositions of these questions, which I discuss in the next section.

> **Modeling the pair-list readings of multiple questions as these nested set structures is a central goal of the proposal below.**

2.3. The presuppositions of multiple questions:

Dayal (2002) shows that multiple questions have two presuppositions (see also Fox, 2012)—domain exhaustivity and point-wise uniqueness—defined in (11). These presuppositions can be paraphrased as requiring that for each question in the family of questions, there must be exactly

one true answer. For (9), this means that there must be a unique student who read each book, and we must provide information about each book in the domain. Under this description, all the books must have a reader, but it is possible that some students will not have read any book.

(11) **The presuppositions of a multiple question (Dayal, 2002):**
  a. <u>Domain exhaustivity</u>: every member of the set quantified over by the overtly moved *wh* is paired with a member of the set quantified over by the in-situ *wh*.
  b. <u>Point-wise uniqueness</u> (*functionhood*): every member of the set quantified over by the overtly moved *wh* is paired with no more than one member of the set quantified over by the in-situ *wh*.

The exhaustivity and uniqueness presuppositions are illustrated in examples (12)-(13) (from Fox 2012). The context in (12a) allows for a pair-list answer (as well as a single-pair) because it is possible to give an exhaustive answer that accounts for each of the children. In the context in (12b), on the other hand, to give a pair-list answer we would be forced to assume that two kids are assigned to the same chair, making this reading deviant. Hence only a single-pair answer is felicitous in this context. The context in (13a) allows for a unique chore to be assigned to each boy, but (13b) leaves one chore that is not assigned to any boy, or else the 1:1 pairing is lost. Hence only a single-pair answer is felicitous in this context.[7]

(12) **Exhaustivity presupposition:**
  a. Guess *which* one of these 3 kids will sit on *which* of these 4 chairs.
      Good with a single-pair answer and with a pair-list answer.
  b. Guess *which* one of these 4 kids will sit on *which* of these 3 chairs.
      Only good with a single-pair answer.

(13) **Uniqueness presupposition:**

  The Jones family (3 boys) will not sit down for dinner before the boys do all of the chores.
  a.   I wonder *which* one of the 3 boys will do *which* one of the 3 chores.
  b.   # I wonder *which* one of the 3 boys will do *which* one of the 4 chores.
      Suggests that the boys will not do all of the chores.

2.4. Alternative semantics

As mentioned above, I assume an interrogative syntax in which *wh*-phrases may be interpreted either in a moved position or in-situ. When a (phonologically) in-situ *wh*-phrase does not undergo

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[7]Note the importance of using singular *which*-phrases, to ensure that we are dealing with a pair-list reading. If plural *which*-phrases are used, e.g. *which boys will do which chores?*, it is possible to give a single-pair answer where each member of the pair is a plurality: *John, Tom, and Bill will set the table, sweep the floor, and do the dishes (respectively)*.

covert movement (e.g. *which student* in (4b) above), it is interpreted via *Rooth-Hamblin alternative computation* (Hamblin, 1973; Kratzer and Shimoyama, 2002: a.o.). Both strategies for establishing a relation between the interrogative C and *wh* have been independently proposed in the literature for the analysis of (phonologically) in-situ *wh*-phrases, and are widely used in current research on the syntax and semantics of multiple *wh*-questions.

Rooth-Hamblin alternatives are a parallel mode of semantic interpretation, where a *focus-semantic value* can be computed compositionally for each syntactic node in the structure, in parallel to its ordinary semantic value (Hamblin, 1973; Rooth, 1985, 1992). This computation has been argued to supply operators such as focus operators and question complementizers with a relevant set of propositional alternatives. Consider the LF representation for the *wh*-in-situ pseudo-English question "Alex likes *who*?" in (14) below. Focus-semantic values—also referred to as *alternatives*—are given for each node.

(14)   **A toy LF of question interpretation through Rooth-Hamblin alternative computation:**
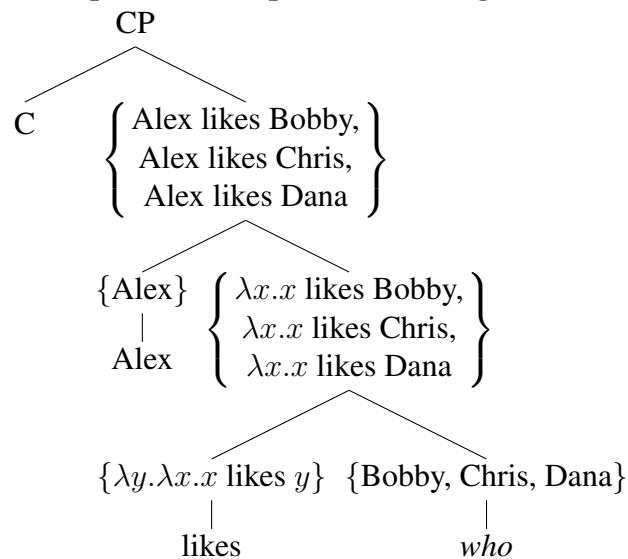
In (14), the *wh*-phrase *who* has a focus-semantic value corresponding to relevant individuals in its domain—here, the animate individuals Bobby, Chris, and Dana. These *alternatives* compose pointwise at each nonterminal node, resulting in the complement of the interrogative C having a set of propositions as its focus-semantic value.[8] The interrogative C then computes the question denotation using these alternatives in its complement, so that these alternative propositions correspond to possible (weak) answers to the question. In this way, the focus-semantic value provided by the in-situ *wh*-phrase is interpreted by the interrogative C. This yields the appropriate question semantics without establishing a syntactically local relationship between the *wh*-phrase and C.

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[8]The semantic denotations here must be interpreted intensionally. World variables are not illustrated here to simplify the presentation.

3. Proposal

I propose that the derivation of a question involves three interrogative components: *Wh*-words, the interrogative complementizer C, and a question operator: ALTSHIFT. Below I discuss each of these components in turn, and then illustrate derivations for English simplex and multiple questions to show how they combine. I note, but will not illustrate for reasons of space, that this proposal is compatible with Cable's (2007; 2010), as well as Heck's (2008; 2009), syntax for pied-piping. As shown in (14), *wh*-words are elements that introduce alternatives into the derivation (Hamblin, 1973). I assume that they do not have a defined ordinary semantic value (Ramchand, 1997; Beck, 2006; Cable, 2010). The denotation of a *which*-NP phrase is equivalent to its NP extension, and its ordinary value is again undefined.

(15) **The semantics of *who* and *what* as sets of alternatives:**

a.
     <u>Ordinary value:</u> $[\![who]\!]^o$ is undefined
     <u>Alternative value:</u> $[\![who]\!]^f = \{x_e : x \in \text{human}\}$

b.
     <u>Ordinary value:</u> $[\![what]\!]^o$ is undefined
     <u>Alternative value:</u> $[\![what]\!]^f = \{x_e : x \notin \text{human}\}$

(16) **The focus-semantic denotation of a *which*-NP phrase is the NP extension:**
$[\![which \text{ student}]\!]^f = [\![\text{student}]\!]^o = \{$ Alex, Bobby, Chris, Dana... $\}$

The interrogative complementizer, C, triggers interrogative movement. In English, this complementizer has an EPP feature that requires at least one *wh*-phrase to occupy its specifier, and furthermore exactly one *wh*-phrase to be pronounced in this position. This interrogative complementizer plays no role in the semantics of the question, and simply passes up the denotation of its sister.

(17) **The semantics of the Complementizer:**
$[\![C]\!] = \lambda P_\tau. \ P$

Finally, the **ALTSHIFT-operator** (AS) sits on the clausal spine and is the source of interrogative semantics. This operator takes a set of propositions (or a set of such sets...) and returns the focus-semantic value of that set as the ordinary value of the question—that is, it takes the alternatives introduced by its sister in the focus domain and shifts them into the ordinary domain. Note that this is a type-flexible version of the semantics for C in Shimoyama (2001) and Beck and Kim (2006). This will be crucial to allow for the family of question derivations for the pair-list readings of multiple questions.[9]

(18) **The semantics of the ALTSHIFT-operator:**

a. $[\![\text{ALTSHIFT } \alpha_\sigma]\!]^o = [\![\alpha_\sigma]\!]^f$

b. $[\![\text{ALTSHIFT } \alpha_\sigma]\!]^f = \{ \ [\![\text{ALTSHIFT } \alpha_\sigma]\!]^o \ \}$ $\sigma \in \{\langle st, t\rangle, \langle\langle st, t\rangle, t\rangle, ...\}$

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[9]Note that in (14) above, I illustrate C as the operator that is responsible for interrogative semantics, to keep with the more standard notation in the literature, but from now on I will use the operator ALTSHIFT for this purpose.

4. The proposal in action

I this section I illustrate derivations for simplex questions and for the single-pair and pair-list readings of multiple questions in English. I show how the proposal set forth in section 3 can derive the correct reading of the questions based on their independently motivated syntax.

4.1. The derivation of a simplex question

I begin with the derivation of simplex questions. A simplified LF for the question *which book did John read?* is given in (19).[10] Notice here that the *wh*-phrase *which book* moves from its position as the complement of *read* to Spec,CP, and that the question operator ALTSHIFT (abbreviated as **AS** in trees) takes this structure as its complement.

(19)   **A (simplified) LF for a simplex *wh*-question:**
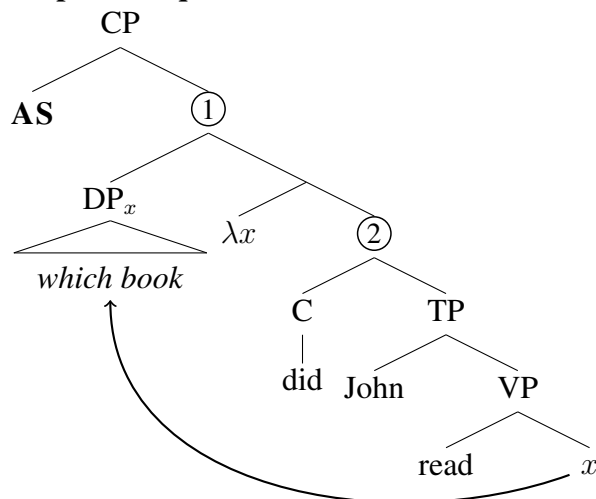
This derivation proceeds as expected—that is, only in the ordinary domain, and using standard composition rules as in Heim and Kratzer (1998)—up to the node labeled ②, whose denotation is the open proposition "that John read x," (20a). This variable is then abstracted over, and it point-wise composes with the set of books in the context, the denotation of the *wh*-phrase *which book*, (20b). Notice that at this point the denotation of node ① can only be composed in the focus dimension. The ordinary dimension of this node is undefined, because the meaning of the *wh*-phrase in it is undefined, (20c). The ALTSHIFT operator takes the alternatives introduced by $[\![①]\!]^f$ and shifts them into the ordinary dimension, yielding the desired interpretation of the question, (20d).

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[10]I assume, but do not show here and in other LFs, successive-cyclic *wh*-movement through phase edges, A-movement of the vP internal subject to Spec,TP, T-to-C movement of the auxiliary verb, etc.

(20)   **Key parts of the derivation of (19):**[11]

    a. $[\![②]\!]^{o} = \lambda w.$ John read x in w

    b. $[\![①]\!]^{f} = \{\lambda w.$ John read x in $w : x \in book\}$

    c. $[\![①]\!]^{o}$ is undefined

    d. $[\![\text{CP}]\!]^{o} = [\![①]\!]^{f} = \{\lambda w.$ John read x in $w : x \in book\}$

Importantly, here the contribution of C is separated from that of ALTSHIFT. C is syntactically ***below*** the *wh*-phrase, and is responsible for interrogative syntax. ALTSHIFT is syntactically ***above*** the *wh*-phrase, and is responsible for interrogative semantics. Moreover, in the derivation of the simplex question, the denotation of ALTSHIFT is identical to the denotation for C given in Shimoyama (2001) and Beck and Kim (2006).

The result of (20d), in a simple context with just three books—Moby Dick, War & Peace, and Oliver Twist (as in section 2)—can be spelled out as in (21):

(21)   **A set of possible answers to the question:**[12]
    $\big\{$ that John read MD, that John read WP, that John read OT $\big\}$

Here I adopt the notion from Dayal (1996) that a question must have a unique maximally informative true answer. This requirement can be enforced by an answer operator, as in (22):

(22)   **The *Ans* operator as Max$_{\text{inf}}$ (Dayal 1996, cf Fox 2012):**[13]
    $[\![Ans]\!](P) = \text{Max}_{\text{inf}}(P)$
    $\text{Max}_{\text{inf}}(P)(w) = \iota p \in P,$ s.t. $w \in p$ and $\forall q \in P\ (w \in q \rightarrow p \subseteq q)$

The *Ans* operator takes as input a set as in (21), and is defined iff there is exactly one true proposition in the set that entails all other true propositions in the set. The propositions in (21) are logically independent of one another. Consequently, for *Ans* to apply to this set, there can only be one true member in the set. This correctly models the contribution of the singular *which*-question here.

With this background in mind, I next show that the proposal put forth here can correctly model the derivation of the single-pair reading of a multiple question, without requiring any additions or changes to the basic theory. For concreteness, I will now present a derivation for a superiority-obeying question. The same logic will also hold for the interpretation of a superiority-violating question, but the syntax will be different, as will be shown in section 4.4.

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[11]To simplify the notation, throughout I represent assignment dependent elements in the denotation using unbound variables.

[12]This set only contains answers for singular individuals, without any pluralities. This is enforced by the meaning of the singular *which*-phrase that was used in (19). World variables have been removed for simplicity of exposition.

[13]Dayal does not use the term Max$_{\text{inf}}$, but the definition she provides is equivalent to Max$_{\text{inf}}$, as proposed in Fox and Hackl (2006) and subsequent work. See also von Fintel et al. (2014).

4.2. The single-pair reading of a multiple question

The tree in (23) shows the LF I assume for superiority-obeying questions in English. Following Pesetsky (2000); Beck (2006); Cable (2007, 2010), a.o., I assume the following derivation: (i) an interrogative probe on C probes its c-command domain. The principe *Attract Closest* (Rizzi, 1990: cf Chomsky 1995, 2000) dictates that DP_x will the probe's first target, since it's closer to C than DP_y.[14] (ii) C agrees with DP_x, and attracts it to its specifier. (iii) C continues probing its c-command domain. Its next goal is DP_y. (d) C agrees with DP_y and attracts it to a lower Spec,CP, where DP_y tucks in below DP_x (Richards, 1997). A pronunciation rule then dictates that the highest phrase in Spec,CP—here, DP_x—is pronounced at the head of its chain, and all remaining *wh*-phrases are pronounced at the tail of their respective chains. As in (19), I assume that an ALTSHIFT operator takes this structure as its sister.

(23)   **The LF of a superiority-obeying multiple question with a single-pair reading:**
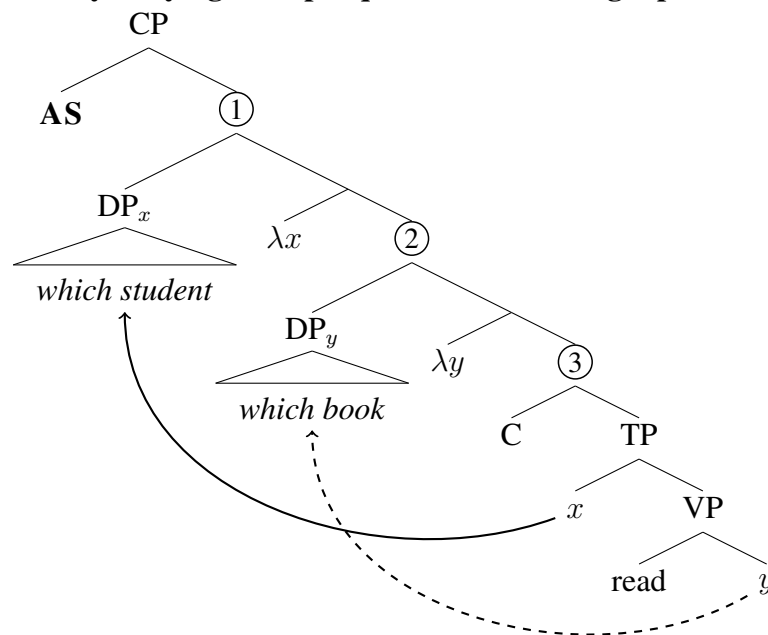
As before, the derivation of the structure up to node ③ is uneventful. At node ③ we have an open proposition "that x read y" (24a). These free variables are bound and point-wise compose with the denotations of the *wh*-phrases *which book* and *which student* at nodes ② and ①, respectively, yielding as the result a set of propositions as the alternatives to node ①, whose ordinary value is again undefined (24e–f). ALTSHIFT takes this alternative value in $\llbracket ① \rrbracket^f$ and returns it as the ordinary value of the question, yielding the desired interpretation (24g).

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[14]X is closer to A than Y iff X asymmetrically c-commands Y.

(24) **Key parts of the derivation of (23):**

    a. $[\![③]\!]^o = \lambda w.\ x$ read y in w

    b. $[\![③]\!]^f = \{\ [\![③]\!]^o\ \} = \{\ \lambda w.\ x$ read y in $w\ \}$

    c. $[\![②]\!]^f = \{\lambda w.\ x$ read y in $w : y \in book\}$

    d. $[\![②]\!]^o$ is undefined

    e. $[\![①]\!]^f = \{\lambda w.\ x$ read y in $w : y \in book, x \in student\}$

    f. $[\![①]\!]^o$ is undefined

    g. $[\![CP]\!]^o = [\![①]\!]^f = \{\lambda w.\ x$ read y in $w : y \in book, x \in student\}$

The resulting meaning is a 'flat' set of propositions, corresponding to the possible answers to the question. In a simple context with three individuals—John, Mary, and Bill—and three books—Moby Dick, War and Peace, and Oliver Twist—this set, can be spelled out as in (25). Again, these propositions are logically independent of one another. Hence, applying the Ans-operator to this set, as above, ensures that exactly one proposition in this set is true, giving rise to a single-pair reading of the multiple question.

(25) **A single-pair reading is modeled as a 'flat' set of propositions:**

$$\left\{ \begin{array}{l} \text{John read MD, John read WP, John read OT, Mary read MD,} \\ \text{Mary read WP, Mary read OT, Bill read MD, Bill read WP, Bill read OT} \end{array} \right\}$$

Crucially, the same compositional ingredients are used here as in the simplex question above. The reason this derivation yields a single-pair reading is that the alternatives from all *wh*-phrases in the structure pointwise compose into a single, flat set of propositions, and a single ALTSHIFT then returns the result as the meaning of the question. As we will see next, matters change if we allow more than one ALTSHIFT operator to occur in the structure.

4.3. The pair-list reading of a superiority-obeying multiple question

Next I turn my attention to the derivation of pair-list readings of multiple questions. I focus first on superiority-obeying multiple questions. I assume here a syntactic derivation identical to the one illustrated in section 4.2 for the single-pair reading of the question, with just one modification: I introduce a second ALTSHIFT-operator into the derivation. This will allow each *wh*-phrase in the structure to be interpreted by a separate ALTSHIFT-operator. As we will see, this yields the desired family of questions denotation for the question.

(26)   **The LF of a superiority-obeying multiple question with a pair-list reading (cf 23):**
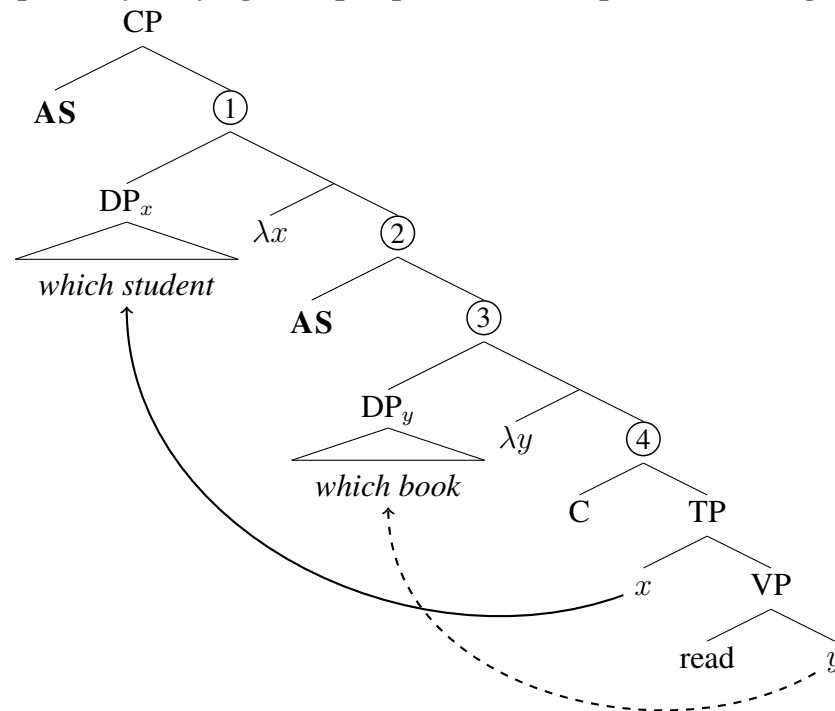
The derivation here proceeds as in (24) up to node ③: the result is the open set of proposition $\{\lambda w. \ x \text{ read } y \text{ in } w : y \in book\}$ (27a). Crucially, at this point, an ALTSHIFT operator takes this set of focus-alternative propositions and returns it as the ordinary value of node ② (27b). As with any other non-focused node, I assume that the focus-semantic value of ② is identical to the singleton set of its ordinary value (27c) (Rooth, 1985, 1992). This node then point-wise composes with the meaning of *which student*, yielding as the meaning of ① the set of sets of alternative propositions: $\{\{\lambda w. \ x \text{ read } y \text{ in } w : y \in book\} : x \in student\}$ (27d). Finally, the higher ALTSHIFT operator takes this set of focus-alternative propositions and returns it as the ordinary value of the question (27e). The result, then is a set of *questions*, or a family of questions denotation.

(27)   **Key parts of the derivation of (26):**
   a. $[\![③]\!]^f = \{\lambda w. \ x \text{ read } y \text{ in } w : y \in book\}$
   b. $[\![②]\!]^o = [\![③]\!]^f = \{\lambda w. \ x \text{ read } y \text{ in } w : y \in book\}$
   c. $[\![②]\!]^f = \{\{\lambda w. \ x \text{ read } y \text{ in } w : y \in book\}\}$
   d. $[\![①]\!]^f = \{\{\lambda w. \ x \text{ read } y \text{ in } w : y \in book\} : x \in student\}$
   e. $[\![CP]\!]^o = [\![①]\!]^f = \{\{\lambda w. \ x \text{ read } y \text{ in } w : y \in book\} : x \in student\}$

This yields a family of questions denotation sorted by the higher *wh*-phrase—*student*. Spelling this out for our small context, the result is (28), identical to our desideratum in (7):

(28)   **A family of questions sorted by *student* yields a pair-list reading:**

$$\left\{ \left\{ \begin{array}{l} \text{John read MD} \\ \text{John read WP} \\ \text{John read OT} \end{array} \right\}, \left\{ \begin{array}{l} \text{Mary read MD} \\ \text{Mary read WP} \\ \text{Mary read OT} \end{array} \right\}, \left\{ \begin{array}{l} \text{Bill read MD} \\ \text{Bill read WP} \\ \text{Bill read OT} \end{array} \right\} \right\} \qquad (= 7)$$

At this point, notice that Dayal's Ans-operator, defined in (22), cannot apply to this set. However, we can recursively define a generalized Ans-operator based on (22) that will apply to each question in this set and yield the *exhaustivity* and *uniqueness* presuppositions of the questions (Dayal, 2002).

(29)   **A recursive definition for Generalized *Ans*:**
   a. $[\![Ans]\!] \left(P_{\langle st,t \rangle} \right) = \lambda w.\text{Max}_{\text{inf}}(P)(w)$
        where $\text{Max}_{\text{inf}}(P)(w) = \iota p \in P$, s.t. $w \in p$ and $\forall q \in P \left(w \in q \rightarrow p \subseteq q \right)$
   b. $[\![Ans]\!] \left(K_{\langle \sigma,t \rangle} \right) = \lambda w.\forall P_\sigma \in K \left([\![Ans]\!] \left(P \right)(w) \right) \qquad\qquad \sigma \in \{\langle st,t \rangle, \langle\langle st,t \rangle, t \rangle, ...\}$

As before, the ι operator introduces a uniqueness presupposition, which derives the presuppositions of the multiple question observed by Dayal in (11). This generalized *Ans* operator will recursively apply to each question in the set in (28) and ensure that it has a unique maximally informative true answer. The result is a single answer to each question in the family of questions—a pair-list reading of the multiple question, where for each student in the context, we must specify the single book that this student read.

4.4.   The pair-list reading of a superiority-violating multiple question

Finally, I turn to the derivation of the pair-list reading of a superiority-violating question. An LF for such a question is illustrated in (30). Following Pesetsky (2000); Beck (2006); Cable (2007, 2010), a.o., I assume that the syntax of such a question is different from that of superiority-obeying questions in one important way. The derivation begins as with a superiority-obeying question: an interrogative probe on C probes its c-command domain. *Attract Closest* dictates that DP_x will the probe's first target, since it's closer to C than DP_y. At this point C agrees with DP_x, but—unlike in superiority-obeying questions—*C does not attract DP_x to its specifier but instead leaves it in-situ.* C continues probing its c-command domain and finds its next goal, DP_y. C agrees with DP_y and attracts it to its specifier. DP_y is hence the only (and hence, the highest) *wh*-phrase in Spec,CP. Following the pronunciation rule from above, it will be pronounced in its moved position—above the in-situ *wh*-phrase DP_x, yielding the superiority-violating word order.[15]

At this point, if a single ALTSHIFT operator takes the structure as its sister, this yields a single-pair question meaning as in section 4.2. For brevity, I will not illustrate this derivation, as it is parallel to the derivation sketched in (23–24) and yields an identical semantics for the question. Instead,

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[15]Here it is important to note that there is no way to derive a superiority-violating word-order if the higher DP_x were attracted to Spec,CP—the pronunciation rule requires that DP_x is LF-in-situ to achieve this word order.

I illustrate here the derivation of the pair-list reading of this structure. Like with the superiority-obeying question, the pair-list reading is modeled as a family of questions. To yield this structure, two ALTSHIFT operators are introduced into the structure: one above *which student* and another above *which book*. This will yield a family of questions denotation keyed on *books*, as desired.

(30)   **The LF of a superiority-violating question with a pair-list reading:**
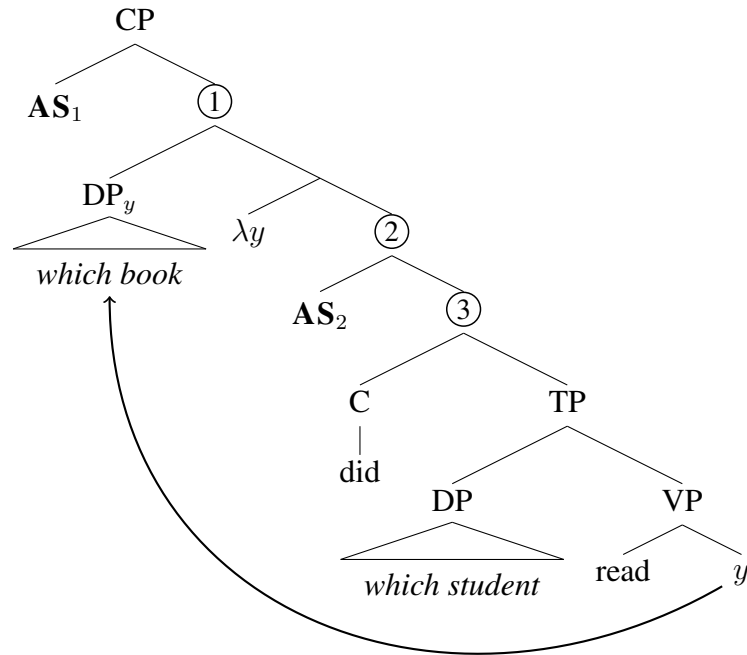
As with the parallel superiority-obeying question, the pair-list reading is derived via a nested set structure, created by interpreting each *wh*-phrase with a separate ALTSHIFT operator.

(31)   **Key parts of the derivation of (30):**

    a. $[\![③]\!]^f = \{\lambda w.\ x \text{ read } y \text{ in } w : x \in student\}$

    b. $[\![②]\!]^o = [\![③]\!]^f = \{\lambda w.\ x \text{ read } y \text{ in } w : x \in student\}$

    c. $[\![②]\!]^f = \{\{\lambda w.\ x \text{ read } y \text{ in } w : x \in student\}\}$

    d. $[\![①]\!]^f = \{\{\lambda w.\ x \text{ read } y \text{ in } w : x \in student\} :\ y \in book\}$

    e. $[\![CP]\!]^o = [\![①]\!]^f = \{\{\lambda w.\ x \text{ read } y \text{ in } w : x \in student\} :\ y \in book\}$

This yields a family of questions denotation sorted by the higher *wh*-phrase—*book*. Spelling this out for our small context, the result is (32), identical to our desideratum in (9). Moreover, applying the generalized *Ans* operator in (29) to this family of questions results in the requirement that each question in the set have one unique maximally informative true answer, correctly modeling the presuppositions of this question. That is, we yield a pair-list reading of the multiple question, where for each book in the context, we must specify the single student who read it.

(32)   **A family of questions sorted by *book* yields a pair-list reading:**

$$\left\{ \left\{ \begin{array}{c} \text{John read MD} \\ \text{Mary read MD} \\ \text{Bill read MD} \end{array} \right\}, \left\{ \begin{array}{c} \text{John read WP} \\ \text{Mary read WP} \\ \text{Bill read WP} \end{array} \right\}, \left\{ \begin{array}{c} \text{John read OT} \\ \text{Mary read OT} \\ \text{Bill read OT} \end{array} \right\} \right\} \qquad (= 9)$$

The difference between this superiority-violating LF and the one for the superiority-obeying question lies in the fact that non-trivial focus-alternatives are computed across a larger portion of the structure. The fact that the base-generated higher *wh*-phrase *which student* is left in-situ in this LF makes predictions for the sensitivity of this structure to *intervention effects*. Following Beck (2006); Kotek (2014), a.o., parts of the structure in which alternatives are computed are susceptible to ungrammaticality, caused by c-commanding *interveners*—certain quantifiers and focus-sensitive operators. For more on this, see the above mentioned works and authors cited therein.

4.5. Summary

The theory developed here builds on existing proposals regarding interrogative syntax, the semantics of *wh*-phrases, the meaning of the interrogative operator, and the presuppositions of the question, combined in a novel way. The primary innovation is the ability of the ALTSHIFT operator to iterate in the structure, deriving the desired nested set structures for superiority-obeying and superiority-violating questions. This is compatible with the range of syntactic structures attested for questions cross-linguistically: here I illustrated structures with overt and covert movement to C, as well as *wh*-in-situ. This proposal is also compatible with languages that are fully in-situ (e.g. Japanese) and those that allow partial movement to positions other than C (e.g. Shona).

In this system, the syntactic and the semantic composition of the question are driven by two separate operators. In syntactic terms, the ALTSHIFT-operator is *higher* than the *wh*-phrases(s) that it interprets. It occupies a position in the C domain, above the C head. It is type-flexible, and it may occur more than once in a structure. In contrast, C is syntactically *lower* than the *wh*-phrase(s) that it attracts to its specifier(s). It is semantically inert, and it only occurs once in a question.[16]

5. Quiz-master questions and nested *which*-phrases

In this section I show that the proposal developed above is able to explain the distribution and interpretation of the possible readings of so-called 'quiz-master' questions and of questions with nested *which*-phrases. Example (33) illustrates a quiz master question. Such questions exceptionally require *wh* to remain in-situ, and often require a unique intonation that gives the question its name. They have been argued to only allow a single-pair answer, but not a pair-list answer:

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[16]Nothing goes wrong if multiple ALTSHIFT operators are stacked at the top of the question, without being separated by *wh*-phrases. In that case, the recursively-defined *Ans*-operator will apply, and ensure that the singleton set it contains must have a unique maximally informative true answer. Hence, regardless of how many sets this singleton set is embedded in, the result is a single-pair reading. Such a derivation may be independently ruled out by considerations of economy, but nothing hinges on this.

(33)   **Quiz-master questions only have single-pair answers:**
       [$_{TP}$ Elvis Presley introduced *which* actress to *which* rock band]?

Similarly, nested *wh*-phrases have been recently argued to systematically lack a pair-list reading (Elliott, 2015). This can be illustrated using the strongly distributive predicate *list*. The examples in (34) show that *list* may only embed a multiple question with a pair-list answer.

(34)   ***List* may only embed questions with a pair-list answer:**
       Context: There are two girls.
       a.   Mary listed *which* girl hit *which* boy.
       b.   # Mary listed *which* one hit *which* one first.

Example (35) now shows that nested *wh*-phrases cannot be embedded under *list*. This incompatibility of *list* and its embedding is explained if nested *wh*-questions may only have a single-pair reading, making them unsuitable complements to the predicate *list*.

(35)   ***List* can't embed a nested *wh*-question:**
       a.   Mary listed *which* book she had borrowed from *which* library.
       b.   # Mary listed [$_{DP}$ *which* book by *which* author] she had read.

The two structures in (33) and (35b), though unusual, have one property in common: *in both cases, the two wh-phrases they contain will necessarily pointwise compose with one another, before an* ALTSHIFT *operator is encountered*. In the case of quiz-master questions, the *wh*-phrases are contained inside TP (and perhaps even *v*P). In the case of nested *wh*-questions, the *wh*-phrases are contained inside a single DP. However, the ALTSHIFT-operator must occupy a position on the clausal spine, above C. This syntactic restriction on the position of ALTSHIFT restricts the available interpretations for these multiple *wh*-questions in a principled manner. In particular, because all the *wh*-phrases in the structure will necessarily point-wise compose with one another into a 'flat' set before any ALTSHIFT operator is encountered, we correctly predict that only single-pair readings are available for these questions. There is no way to interleave the *wh*-phrases and ALTSHIFT-operators in these structures, as is required for the derivation of pair-list readings.

6. Conclusion

This paper presented a new framework for the syntax and semantics of interrogative constructions, building on well-motivated syntactic assumptions for the derivations of simplex and multiple questions. This proposal is compatible with both major approaches to the syntax and semantics of pied-piping (Cable, 2007, 2010; Heck, 2008, 2009), and it combines insights developed in different parts of the literature concerning superiority effects, the presuppositions of questions, the readings of multiple questions (single-pair vs pair-list), and intervention effects in multiple questions. It thus achieves a wider empirical coverage than other theories of interrogative syntax-semantics

(e.g. Hamblin, 1973; Karttunen, 1977; Hagstrom, 1998; Cable, 2007, 2010; Cheng and Demir-dache, 2010; Fox, 2012; Nicolae, 2013). At the same time, this proposal is simpler than these other previous proposals:

(36) **A simple semantics for the interrogative components in a derivation:**
    a. *Wh*-words introduce alternatives into the derivation.
    b. The interrogative complementizer C passes up the denotation of its sister. It may only occur once in the structure, *below* moved *wh*-phrases.
    c. The interrogative operator ALTSHIFT turns the alternative value of its sister into the ordinary value of the question. It is type-flexible, may recur in the structure, and occurs *above* the *wh*-phrases that it interprets.

The single-pair and pair-list readings of multiple questions are derived from minimally different LFs, which differ only in the number of ALTSHIFT operators that occur in the structure. Finally, I showed that this theory explains exceptional cases where only a single-pair reading of the question is available, in quiz-master questions and in nested *wh*-questions.

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Intervention effects in relative pronoun pied-piping: experimental evidence[*]

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Abstract. This paper contributes experimental evidence regarding the question of how relative pronouns are interpreted in English non-restrictive relative clauses with relative pronoun pied-piping (RPPP). Kotek and Erlewine (2015) and Erlewine and Kotek (to appear b) claim that the *wh*-relative pronoun is sensitive to *intervention effects* inside its pied-piping constituent (cf Sauerland and Heck 2003, Cable 2010, Kotek and Erlewine to appear). In this paper we present the results of a web-based grammaticality judgment survey which supports this claim. We discuss the nature of the intervention judgment, which is notoriously subtle, and how it might be modeled in grammar. The sensitivity of RPPP to intervention effects has important implications for the formal analysis of English non-restrictive relative clauses, supporting the view that relative pronouns are interpreted in-situ without covert movement out of its pied-piping.

Keywords: relative pronoun, pied-piping, non-restrictive relative clause, intervention effects, grammaticality judgment survey, gradience in grammar

1. Introduction

The literature of the past three decades on the syntax/semantics of *wh*-constructions has identified broadly two different strategies for the scope-taking of surface in-situ *wh*-words: covert movement and in-situ interpretation. See e.g. Pesetsky (1987), Tsai (1994), Reinhart (1998), Cheng (2009) for discussion of these two strategies. Although this literature has overwhelmingly focused on the interpretation of *wh*-in-situ in *wh*-questions, *wh*-words are also used for a range of other purposes and their scope-taking can also be investigated in similar terms. Against this backdrop, in this paper we investigate the interpretation of *wh*-words as relative pronouns in English non-restrictive relative clauses.

Relative pronouns in English relative clauses undergo obligatory fronting to the edge of the relative clause, as in (1). In this simple case, we can interpret the overt movement step as abstracting over the object position of *find*, resulting in the interpretation of the derived predicate "λx . we found a copy of x in the archive" which must hold of the head noun (here, *this letter by Lincoln*). See Heim and Kratzer (1998) for one standard treatment, focusing on English restrictive relative clauses.

(1) **Obligatory relative pronoun fronting in English relative clauses:**
  We read this letter by Lincoln, [$_{RC}$ *which* we found a copy of ____ in the archive].

The interpretation of the relative clause is complicated by the availability of *relative pronoun pied-piping* (RPPP). Consider the variant of (1) with pied-piping in (2), which has the same interpretation as (1). In this case, there is not a straightforward way of retrieving the same predicate "λx . we found a copy of x in the archive" which must hold of the head noun. Although overt *wh*-movement takes place in the derivation of the relative clause, the possibility of pied-piping forces us to consider the interpretation of the relative pronoun as an in-situ *wh*-word, inside its pied-piping.

(2)   **Optional relative pronoun pied-piping (RPPP) (cf 1):**
      We read this letter by Lincoln, [$_{\text{RC}}$ [$_{\text{RPPP}}$ a copy of *which*] we found _____ in the archive].

Following the literature on different interpretational strategies for *wh*-in-situ in *wh*-questions, we consider two approaches to the interpretation of relative clauses with RPPP, schematized in (3–4) below. Option 1 involves covertly moving the relative pronoun out of the RPPP to the edge of the relative clause at LF (3), which straightforwardly yields the same derived predicate for the relative clause as in the non-pied-piped variant in (1).[1] Option 2 involves interpreting the *wh*-relative pronoun in-situ within the pied-piping at LF (4). We indicate overt movement with solid arrows, covert movement with dashed arrows, and areas of in-situ interpretation with squiggly arrows.

(3)   **Option 1: covertly move the relative pronoun out of the RPPP**
      a.   <u>LF:</u> [$_{\text{RC}}$ *which* λy [[$_{\text{RPPP}}$ a copy of y] λx . we found x in the archive]]

      b. $[\![\text{RC}]\!] = \lambda y$. (λx . we found x in the archive) (a copy of x)
              $= \lambda y$. we found a copy of y in the archive

(4)   **Option 2: interpret the relative pronoun in-situ within RPPP**
      <u>LF:</u> [$_{\text{RC}}$ [$_{\text{RPPP}}$ a copy of *which*] λx . we found x in the archive]
           in-situ interpretation   *movement*

These two options for the analysis of RPPP in non-restrictive relatives make different predictions for the region between the relative pronoun and the edge of the relative clause. The covert movement option (3) predicts that the relative pronoun cannot be inside a syntactic island, inside the pied-piping, whereas alternative computation (4) is not sensitive to islands (see e.g. Rooth 1985). In contrast, the use of Rooth-Hamblin alternative computation to interpret relative pronouns in-situ (4) is susceptible to so-called *intervention effects*, which we introduce in the following section, but the covert movement option (3) predicts no such sensitivity.

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[1]Heim and Kratzer (1998: p. 106) presents Option 1 for pedagogical purposes. Option 1 here also stands in for other options which involve a movement relation between the overt position of the relative pronoun and the edge of the relative clause. For example, a derivation where the head NP (here, *letter by Lincoln*) is moved to its surface position from the position of the relative pronoun, as in the analyses of Kayne (1994), Bhatt (2002), a.o., would also yield a similar structure at LF.

This paper is structured as follows. In section 2 we present background on intervention effects and their use in diagnosing regions of in-situ interpretation. In section 3 we return to the problem of relative pronoun pied-piping (RPPP) and the predictions of the intervention effect diagnostic. We present our experimental paradigm and results in section 4 and conclude in section 5.

2. Background: Detecting in-situ interpretation through intervention effects

2.1. Intervention effects in *wh*-questions

The term *intervention effect* is traditionally used to describe a situation in which a *wh*-question is rendered ungrammatical because an in-situ *wh*-phrase is c-commanded by an *intervener*—certain quantificational and negative elements, as well as focus-sensitive items—at LF (Beck 2006; see also Beck 1996, Kim 2002, a.o.).

Intervention effects are most easily observed in *wh*-in-situ languages such as Japanese and Korean.[2] In the following paradigm from Beck and Kim (1997), example (5a) shows that Korean questions generally do not require *wh*-fronting. However, when the subject above the in-situ *wh*-word is changed from 'Minsu' to the focus-sensitive expression 'only Minsu,' the question becomes ungrammatical (5b). This problem can be avoided by scrambling the *wh*-word over 'only Minsu' as in (5c), so that the intervener no longer c-commands the *wh*-word. Interveners are bolded and *wh*-words are italicized throughout.

(5)   **Intervention effect in Korean *wh*-questions:**   (Beck and Kim 1997)

    a.   Minsu-nun *nuku*-lûl   po-ass-ni?
           Minsu-TOP who-ACC see-PAST-Q

           'Who did Minsu see?'

    b. * Minsu-**man** *nuku*-lûl   po-ass-ni?   c. √*Nuku*-lûl Minsu-**man** ___ po-ass-ni?
           Minsu-only who-ACC see-PAST-Q   who-ACC Minsu-only   see-PAST-Q
           Intended: 'Who did only [Minsu]$_F$ see?'   'Who did only [Minsu]$_F$ see?'

The intervention effect in (5b) and its amelioration through scrambling in (5c) motivate the idea that *intervention effects affect regions of in-situ interpretation, not movement* (Beck 2006, Beck and Kim 2006, Kotek 2014). The authors cited here assume a theory of in-situ interpretation that is based on Rooth-Hamblin alternative computation (see Hamblin 1973, Rooth 1985: a.o.). Informally, interveners interrupt the projection of alternatives before they reach the interpreting operator—in this case, interrogative C.[3] Interveners do not affect overt or covert movement possibilities. The schema in (6) from Beck (2006) reflects the contrast in (5b–c):

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[2]Intervention effects can also be observed in *wh*-fronting languages such as English and German, under certain circumstances. See Pesetsky (2000) and Beck (2006) for details.

[3]Here we will concentrate on the distribution of intervention effects and be less concerned with the mechanism that causes intervention. See Beck (2006) for one prominent view.

(6)   **Intervention affects in-situ interpretation (alternative computation), not movement:**

    a.   * [$_{CP}$ C ... **intervener** ... *wh*]   (5b)

    b.   ✓ [$_{CP}$ C ... *wh* ... **intervener** ... *t*]   (5c)

Here we note that judgments concerning intervention effects are notoriously difficult.[4] As a result, different authors studying intervention effects have reported the degradation of examples caused by intervention as "*", "?*", or "??". We will simply indicate degraded examples throughout with a "*". We return to this issue after presenting our experiment in section 4.

2.2.   Intervention effects in interrogative pied-piping

Sauerland and Heck (2003), Cable (2007), and Kotek and Erlewine (to appear) show that intervention effects also occur inside pied-piped constituents triggered by interrogative *wh*-movement:[5]

(7)   **Intervention effect in English interrogative pied-piping:** (based on Cable 2007: p. 262)

    a.   ✓ [$_{pied-piping}$ A picture of *which* president] does Jim own _____?

    b.   * [$_{pied-piping}$ **No** pictures of *which* president] does Jim own _____?

    c.   * [$_{pied-piping}$ **Few** pictures of *which* president] does Jim own _____?

    d.   * [$_{pied-piping}$ **Only** PICTURES of *which* president] does Jim own _____?

If an intervener is placed between the *wh*-word and the edge of pied-piping, the result is ungrammatical due to an intervention effect. This is explained by the view that interrogative *wh*-words are interpreted *in-situ* within pied-piping constituents, using Rooth-Hamblin alternative computation (Cable 2010, Kotek and Erlewine to appear), as schematized in (8). In (7), only example (7a) is grammatical, because (7b–d) involve an intervener occurring inside the region where alternatives must be projected for the interpretation of the question.

(8)   **The pied-piping intervention schema:**

    *[$_{pied-piping}$ ... **intervener** ... *wh* ...] λx .   ... x ...

                  alt. computation   *movement*

We know that it is specifically this region within the pied-piping that is sensitive to intervention because different choices of pied-piping size can lead to structures where the intervener is stranded

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[4]For example, see discussions in Pesetsky (2000), Tomioka (2007, 2009), and Kotek (2014), as well as Beck (1996: fn. 2) and Butler (2001: fn. 1).

[5]See also Erlewine and Kotek (2014) for parallel results from overt and covert focus movement in English.

outside the pied-piped material. Such questions are grammatical, as seen in (9) in comparison with (7b) above. This reflects the fact that intervention effects affect Rooth-Hamblin alternative computation, here used to interpret the *wh*-word in-situ within the pied-piping constituent, but not structures that are derived through movement chains and interpreted through λ-abstraction.

(9)   **Intervention avoided with smaller pied-piping (cf 7b):**   (Cable 2007)

     a.   ✓[pied-piping Of *which* president] does Jim own **no** pictures ____?

     b.   ✓[pied-piping *Which* president] does Jim own **no** pictures of ____?

3. Intervention effects in RPPP

We now return to the question of relative pronoun pied-piping (RPPP). Recall from the introduction that there are broadly two approaches to the interpretation of the relative pronoun inside RPPP: movement and in-situ interpretation. These options from (3–4) above are schematized here in (10). Following previous work on the interpretation of interrogative *wh* pied-piping, reviewed in §2.2 above, we take the mechanism of in-situ interpretation in Option 2 to be Rooth-Hamblin alternative computation.

(10)   **Two options for the interpretation of relative pronouns with pied-piping:**

     a. Option 1: covertly move the relative pronoun out of the RPPP

       LF: $[_{\text{RC}}\ wh_{\text{RP}}\ \lambda y\ [[_{\text{RPPP}} \ldots y \ldots]\ \lambda x\ .\quad \ldots x \ldots \quad]]$

     b. Option 2: interpret the relative pronoun in-situ within RPPP

       LF: $[_{\text{RC}}\ [_{\text{RPPP}} \ldots wh_{\text{RP}} \ldots]\ \lambda x\ .\quad \ldots x \ldots \quad]$
         alt. computation   *movement*

Previous work on the semantics of relative pronouns have largely favored Option 1, or similar movement derivations which yield a substantially equivalent LF representation (e.g. Kayne 1994, Bhatt 2002; see footnote 1), with some authors arguing that in fact a Rooth-Hamblin alternatives-based approach cannot be made to work for RPPP (Sternefeld 2001, Sauerland and Heck 2003; see discussion in Kotek and Erlewine 2015). Against this backdrop, in Kotek and Erlewine (2015) and Erlewine and Kotek (to appear b), we develop a semantics for non-restrictive relatives which interprets the relative pronoun in-situ through alternative computation within its RPPP (Option 2), solving the objections to this approach raised by previous authors.

Our proposal which interprets the relative pronoun in-situ using alternative computation (Option 2) was motivated by two new facts regarding RPPP. First, embedding a relative pronoun inside a syntactic island does not lead to ungrammaticality, as observed in (11), reproduced from our previous work. This is unexpected if the interpretation of RPPP necessarily involves movement (Option 1).

(11)   **The relative pronoun can be inside an island, inside RPPP:**
       This portrait,
       a. $^\checkmark$ [$_{RC}$ [$_{RPPP}$ the background of *which*] is quite stunning],
       b. $^\checkmark$ [$_{RC}$ [$_{RPPP}$ the background [$_{RC}$ that was chosen for *which*]] is quite stunning],
                                                                                ...sold for a million dollars at auction.

The second fact is that the relative pronoun is sensitive to intervention effects inside its RPPP, in the same way that interrogative *wh*-pied-piping is sensitive to intervention (section 2.2 above). The motivating example for this fact is also reproduced here. Example (12a) provides a baseline. Examples (12b–d) contain interveners and judged as significantly degraded, whereas examples (12e–g) contain various non-intervening determiners and do not exhibit intervention effects.[6] Note that the set of interveners presented in (12b–d) parallel the determiners shown to be interveners in English interrogative *wh* pied-piping, as in example (7) above.

(12)   **Intervention effect in RPPP with known interveners *no, very few, only*:**
       I want to try this recipe,

       Baseline:
       a. $^\checkmark$ [$_{RC}$ [$_{RPPP}$ the ingredients for *which*] I (already) have ____ at home].
       Interveners:
       b.   * [$_{RC}$ [$_{RPPP}$ **no** ingredient(s) for *which*] I have ____ at home].
       c.   * [$_{RC}$ [$_{RPPP}$ **very few** ingredients for *which*] I have ____ at home].
       d.   * [$_{RC}$ [$_{RPPP}$ **only** [one]$_F$ ingredient for *which*] I have ____ at home].
       Non-interveners:
       e. $^\checkmark$ [$_{RC}$ [$_{RPPP}$ an ingredient for *which*] I'm missing ____].
       f. $^\checkmark$ [$_{RC}$ [$_{RPPP}$ three ingredients for *which*] I (already) have ____ at home].
       g. $^\checkmark$ [$_{RC}$ [$_{RPPP}$ many ingredients for *which*] I (already) have ____ at home].

Finally, as is also the case with interrogative *wh* pied-piping (9), intervention is avoided if a smaller pied-piping constituent is chosen which does not contain the intervener:

(13)   **Intervention avoided with smaller RPPP:**
       I want to try this recipe,
       a.   * [$_{RC}$ [$_{RPPP}$ **no** ingredients for *which*] I have ____ at home].   (=12b)
       b. $^\checkmark$ [$_{RC}$ [$_{RPPP}$ for *which*] I have **no** ingredients ____ at home].
       c. $^\checkmark$ [$_{RC}$ [$_{RP}$ *which*] I have **no** ingredients for ____ at home].

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[6]We report examples (12c–d) with ?? in Erlewine and Kotek (to appear b) as a consensus judgment across various speakers in in-person elicitation. As noted in section 2.1 above, we simply annotate degraded examples with * here.

That relative pronouns in RPPP are sensitive to intervention effects but not islands motivates the interpretation of relative pronouns in-situ through alternative computation (Option 2; 10b), as we argue in Kotek and Erlewine (2015) and Erlewine and Kotek (to appear b).

We note that we have also discovered a second, distinct pattern of judgments for some native speakers, thanks to a comment by Amy Rose Deal at the Sinn und Bedeutung 20 meeting. These speakers report that RPPP is subject to islands, detecting a contrast in pairs such as (11) but that there is no sensitivity to intervention as in (12). We believe such speakers to represent a minority of the population who may in fact be interpreting RPPP through Option 1 (10a). For present purposes we will concentrate on the pattern of judgments presented above and we leave more careful documentation of this second pattern of judgments for future work.

4. Experiment

We now turn to the contribution of this paper, the results of a web-based grammaticality judgment survey which corroborates our claim that RPPP is sensitive to intervention effects. The experiment presented native speakers with sentences to be judged on a 7-point Likert scale.

4.1. Participants

64 participants were recruited for this experiment through Amazon Mechanical Turk. Participants were paid US$0.40 for their participation. Participants were asked about their native language but were told that payment was not contingent on their response. To further ensure that only native speakers of English participated in the experiments, IP addresses of participants were restricted to the US using Amazon Mechanical Turk's user interface. The average time for completion of the survey was 8 minutes and 5 seconds. Two participants were excluded from the analysis because they did not indicate that they were native speakers of English.

4.2. Materials and design

The experiment had a $2{\times}2$ design, crossing the presence of an intervener ($-$intervener, $+$intervener) with the size of pied-piping (small pied-piping, large pied-piping). Two interveners were used: ***no*** and ***only*** *one*. For items without an intervener, the determiners *every*, *some*, and *a* were used. The small pied-piping option either included movement of the relative pronoun alone or pied-piping of a preposition along with the relative pronoun; the choice was made based on the option that sounded more natural to the authors. Large pied-piping was always of DP size. Eight sets of sentences were constructed, each with four different versions as in (14).[7] The full set of target items can be found in the Appendix.

(14) **Sample target item:**
       My student is studying this letter by Lincoln,

   a. [$_{RC}$ *which* we found a copy of _____ in the archive].   *−int., small p.-p.*

   b. [$_{RC}$ [$_{RPPP}$ a copy of *which*] we found _____ in the archive].   *−int., large p.-p.*

   c. [$_{RC}$ *which* we found **only** [one]$_F$ copy of _____ in the archive].   *+int., small p.-p.*

   d. [$_{RC}$ [$_{RPPP}$ **only** [one]$_F$ copy of *which*] we found _____ in the archive]. *+int., large p.-p.*

In addition, 24 fillers were included in this study, with the following structure. 6 grammatical sentences and 6 ungrammatical sentences were chosen from the materials in Sprouse, Schütze, and Almeida (2013). 6 items contained ungrammatical long-distance dependencies. The final 6 contained relative clauses of varying complexity, half appositive and half restrictive, with no pied-piping, which were all grammatical.

To these 32 items, 6 items from a second, separate experiment were added, all containing appositive relative clauses. The resulting 38 items were randomized, and 8 lists were created using a Latin Square design. Each two target items had at least one filler item between them, and there were at least two filler items at the beginning and end of each list. Randomization and list-creation was done using *turktools* (Erlewine and Kotek to appear a).

Participants were instructed to rate the sentences on a 7-point Likert scale. They were reminded that they might not be uttering the sentences by themselves, but might nevertheless have an intuition as to how natural they are. The scale was marked with numbers 1–7, with 1 being the most unnatural and 7 being the most natural. All participants completed the entire experiment. A counter helped ensure that all sentences were rated.

4.3. Results

Filler items were coded as grammatical or ungrammatical, with grammatical items expected to be rated as 5–7 and ungrammatical items expected to be rated as 1–3, on the 7-point Likert scale. The overall accuracy on filler items across participants in this experiment was 88.5%. One filler item was excluded from consideration because of low accuracy rates (54.8%). No other item had an average accuracy rate below 80%. Seven participants were excluded from the analysis because of low accuracy on the remaining 23 filler items (below 75%).[8]

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[7]In one item set, (19), an adverb was changed between the +/−intervener conditions, to make each item maximally plausible.

[8]Nine participants would be excluded if the accuracy cutoff were raised to 80%. The major results reported below remain unchanged in that case.

The mean ratings of each condition in the target items are summarized in the table below and also represented in the graph at right. Error bars indicate standard errors. Recall that the crucial condition where an intervention effect is expected is +*intervener, large pied-piping*:

Condition	Mean score
−*intervener, small pied-piping*	4.76
−*intervener, large pied-piping*	4.45
+*intervener, small pied-piping*	4.89
+*intervener, large pied-piping*	3.92

Table 1: Ratings for each condition (1–7 Likert scale)
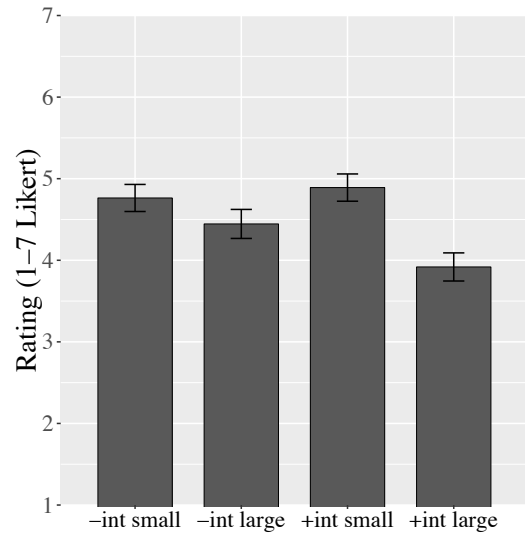
A linear mixed effects model was fit to the data using the *R* package *lme4* (Bates and Sarkar 2007). The model predicted the mean rating of target sentences from the two factors of interest: *intervener* (−intervener vs. +intervener) and *pied-piping* (small vs. large). The model contained random intercepts and slopes for both predictors for subjects and items (Baayen 2004, Barr et al. 2013).

The results show a main effect of *pied-piping* and a *intervener×pied-piping size* interaction. A log likelihood test comparing this model to one without the interaction term was significant, $p < 0.05$. This result is driven by the fact that items that contain interveners inside large pied-piping are degraded compared to items with no intervener, smaller pied-piping, or both. The results of the model are summarized in Table 2.

Predictor	Coefficient	Standard Error	t value
Intercept	4.8804	0.3421	14.264
intervener	−0.1194	0.2668	−0.447
pied-piping size	−0.9673	0.2684	−3.604
intervener×pied-piping size	0.6537	0.2744	2.382

Table 2: Results of the linear mixed effects model

4.4. Discussion

The experimental results reflect a statistically significant effect of intervention, specifically observed in the *intervener×pied-piping size* interaction term (Table 2). The interaction term shows that the particular combination of intervener presence and pied-piping size led to a greater effect on item ratings than would be predicted by the effects of intervener presence and pied-piping size alone. This confirms the prediction that RPPP is sensitive to intervention effects.

5. Discussion and conclusion

As we discussed in section 2.1, judgments concerning intervention effects are notoriously difficult across languages and constructions. This was reflected in speaker responses to our RPPP intervention paradigm in (12) as well; see footnote 6. The apparent subtlety of the contrasts in RPPP and potential speaker variation motivated the use of a larger-scale, controlled experiment, to determine whether such an intervention effect as in (12–13) can be established with statistical significance.

Our experiment finds a significant *intervener×pied-piping size* interaction, confirming the prediction of intervention effects inside RPPP. However, when examining the raw average ratings across conditions in our experiment, the effect of intervention appears small. The condition of interest (+*intervener*, *large pied-piping*) was judged with an average rating of 3.92, compared to an average rating of 4.70 across the other conditions, on a 7-point Likert scale. This appears to suggest that the intervention effect, while real, is not a strong contrast between categorically grammatical and categorically ungrammatical items.

We would like to offer two thoughts on this issue. First, we are weary of over-interpreting the absolute ratings. Experimental measures of grammaticality are affected by the relative grammaticality of other items presented, including other target items but also fillers. The fact that non-intervention conditions—which we believe to be fully grammatical—were judged with an average rating of 4.70 shows that these target items involving non-restrictive relative clauses were in general complex and difficult to judge. The lower rating of the condition of interest must be judged relative to this lower ceiling, instead of being evaluated over the full 1–7 scale.

Second, experimental research has motivated the existence of *soft constraints* in grammar which lead to gradient judgments of the form reported here (see e.g. Keller 2000, Sorace and Keller 2005, Featherston 2005). The results here may indicate that intervention effects do not result in categorial ungrammaticality, but rather in a detectable degradation in acceptability. This accords with the responses to intervention effect items by native speakers in our in-person elicitation, which we noted above.

There is, however, a potential issue with this account of intervention as a soft constraint. The widely adopted Beck (2006) account for intervention effects, also adopted in our own previous work on intervention in English pied-piping, predicts intervention configurations to be completely uninterpretable, rather than resulting in a systematic minor degradation. We hypothesize that this reflects that there are *two strategies* for the interpretation of pied-piping in the grammar: one preferred strategy, susceptible to intervention, and another strategy which is dispreferred but unaffected by interveners.

There is a precedent for this approach in the domain of interrogative *wh*-intervention. Multiple *wh*-questions can have single-pair or pair-list readings. The addition of interveners in certain English multiple *wh* configurations leads to an intervention effect, which is detected differently by

different speakers. Some speakers report that the resulting question is fully ungrammatical whereas others report the loss of the pair-list reading only, with a surviving single-pair interpretation (Pesetsky 2000: pp. 60–61, Beck 2006: fn. 4). The apparently gradient judgments for interrogative *wh* intervention, then, can be accounted for in this way, as the result of two strategies: a pair-list interpretation strategy which is sensitive to intervention and an alternative strategy which is immune to intervention but does not yield the pair-list reading.[9]

Extending this logic to RPPP, we take our results to indicate that a preferred strategy for relative pronoun interpretation is indeed the intervention-sensitive strategy of Rooth-Hamblin alternative computation (Option 2). However, the fact that our crucial intervention items are not strictly ungrammatical may reflect the existence of an alternative, generally dispreferred interpretational option available to at least some speakers, which may be a movement-based variant (Option 1). Further work is necessary, both empirically and theoretically, to understand this aspect of intervention effects.

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[9]See Butler (2001) for a sketch of how this may be achieved within a dynamic semantic approach, and Kotek (2014) for the idea that the remaining interpretational mechanism is one that produces echo-questions.

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Appendix: experimental items

Below are the target items used in our experiment. Each item set is comprised of four conditions, presented here in this order:

   a. −intervener, small pied-piping

   b. −intervener, large pied-piping

   c. +intervener, small pied-piping

   d. +intervener, large pied-piping

(15)   The detective solved the Willis murder,
      a.   which the police had interviewed every witness to.
      b.   every witness to which the police had interviewed.
      c.   which the police had interviewed only one witness to.
      d.   only one witness to which the police had interviewed.

(16)   Susan is preparing a story on the Zika virus,
      a.   which she's interviewed some researchers of.
      b.   some researchers of which she's interviewed.
      c.   which she's interviewed no researchers of.
      d.   no researchers of which she's interviewed.

(17)   Agent Sanders was assigned to investigate the use of marijuana,
      a.   which she recognizes every slang term for.
      b.   every slang term for which she recognizes.
      c.   which she recognizes no slang term for.
      d.   no slang term for which she recognizes.

(18)   This is a very rare delicacy,
      a.   for which a recipe has appeared in print.
      b.   a recipe for which has appeared in print.
      c.   for which no recipe has appeared in print.
      d.   no recipe for which has appeared in print.

(19)   Mathematicians love to discuss the Graph Isomorphism problem,
      a.   for which a solution has now been found.
      b.   a solution for which has now been found.
      c.   for which no solution has ever been found.
      d.   no solution for which has ever been found.

(20)   I want to watch the new Kristovsky film,
      a.   which I've seen a review of.
      b.   a review of which I've seen.
      c.   which I've seen only one review of.
      d.   only one review of which I've seen.

(21)   My student is studying this letter by Lincoln,   *reproduced above as (14)*
      a.   which we found a copy of in the archive.
      b.   a copy of which we found in the archive.
      c.   which we found only one copy of in the archive.
      d.   only one copy of which we found in the archive.

(22)   Malcolm wrote his thesis on The Cartessan War,
      a.   which he actually read every book about.
      b.   every book about which he actually read.
      c.   which he actually read no book about.
      d.   no book about which he actually read.

Acquisition as a window on the nature of NPIs

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Abstract. Dutch modal verb *hoeven* 'need' is a negative polarity item (NPI) (Zwarts 1981, Hoeksema 2000), which survives in all anti-additive, and some but not all downward entailing (DE) contexts. The aim of the paper is to explore the reason why Dutch *hoeven* is not allowed in all DE-contexts – as observed for NPIs such as *any*-terms. We answer this question by looking at acquisition. The reasoning is straightforward: the analysis underlying a linguistic phenomenon is a product of children's acquisition of it. Data collected from a total of 132 monolingual Dutch children (2;09–5;10; M = 4;04; SD = 9.3 months) in an elicited imitation task demonstrate a learning path of *hoeven* in which children start with two lexical frames [HOEF NIET] 'NEED NOT' and [HOEF GEEN] 'NEED NO' and switch to an abstract analysis of it later on: [HOEF NEG] 'NEED NEG'. Given this abstract analysis, emerging as a result of language acquisition, we argue that *hoeven* is an NPI because of its lexical dependency with the abstract negation NEG (cf. Postal 2000). This in turn explains the distribution of the Dutch NPI restricted to some but not all DE-contexts: *hoeven* is only allowed in those DE-contexts that incorporate the abstract negation NEG.

1. Introduction

Dutch modal verb *hoeven* 'need' is a negative polarity item (NPI), which occurs in negative contexts only (Zwarts 1981, Hoeksema 2000, Van der Wouden 1997). Similar to English *any*-terms, well-described in the literature, *hoeven* is restricted to downward entailing (DE) contexts (cf. Ladusaw 1979). For instance, *hoeven* is licensed by the sentential negative marker *niet* 'not', as in (1a), negative indefinites such as *niemand* 'nobody' as in (1b), semi-negative expressions just like *nauwelijks* 'seldom' as in (1c), exclusive adverbs such as *alleen* 'only' as in (1d). However, *hoeven* is not licensed in all DE-contexts that license *any*-terms. In conditional clauses or the restriction of a universal quantifier, which sanction *any*-terms, for instance, *hoeven* is ungrammatical as shown in (2a) and (2b), respectively.

(1) a.   Jan   hoeft niet   te   koken.
             John   needs not   to   cook
             'John does not need to cook.'
      b.   Niemand hoeft te   koken.
             nobody needs to   cook
             'Nobody needs to cook.'
      c.   Jan   hoeft nauwelijks   te   koken.
             John   needs seldom   to   cook
             'John seldom needs to cook.'
      d.   Jan   hoeft alleen te   koken.
             John   needs only   to   cook
             'John only needs to cook.'

(2) a. *Iedereen die   hoeft te   koken moet nu   beginnen.
         everyone   that   needs to   cook   must now   start
         Intended: 'Everyone that needs to cook must start now.'
     b. *Als Jan hoeft te koken   moet hij   nu   beginnen.
         if   John needs to cook   must he   now   start
         Intended: 'If John needs to cook, he must start now.'

In simple affirmative contexts, the appearance of *hoeven* is ungrammatical (Hoeksema 1994, 2000, Van der Wouden 1997, among others) – as is observed for all NPIs. See below:

(3) *Jan   hoeft te   koken.
     John   needs to   cook
     Intended: 'John needs to cook.'

The aim of this paper is to explore the reason why Dutch *hoeven* exhibits a distributional pattern that is restricted to some but crucially not all DE-contexts. In other words, how is *hoeven* represented in the grammar such that Dutch speakers only use it the way described above?

In order to answer this question, we will look at acquisition. The reasoning is straightforward: the analysis underlying a linguistic phenomenon is a product of children's acquisition of it. By analysing children's performance in an elicited imitation task (N=132; 2;09–5;10; M = 4;04; SD = 9.3 months), this paper presents a learning path of *hoeven* from two lexical frames [HOEF NIET] and [HOEF GEEN] to an abstract analysis [HOEF NEG]. Moreover, the paper shows what the acquisition data can tell us about the nature of *hoeven* – an atypical NPI in terms of distribution. Under the hypothesis that [HOEF NEG] is the analysis that emerges as a result of acquisition, *hoeven*'s distribution restricted to some but crucially not all DE-contexts is explained as a consequence of its lexical association with the abstract negation NEG (cf. Postal 2000), since NEG is incorporated in merely some but not all DE-contexts (Iatridou and Zeijlstra 2013).

The paper is organised as follows. We start out with a brief introduction to the various negative environments that may license NPIs (Section 2). Next, we introduce our experiment: the elicited imitation task (Section 3). Afterwards, we present our regression results (Section 4) and analysis (Section 5), which are followed by discussion and conclusion (Section 6).

2. Negative contexts

Ladusaw (1979) proposes that NPIs are generally licensed in DE-contexts: contexts in which the entailment relation goes from set to subset (see also Fauconnier 1975, 1978). DE-contexts can be further divided into three types, depending on their logico-semantic behaviours: anti-morphic contexts, anti-additive contexts, and DE-contexts (Zwarts 1981, 1986, 1995).[1] These contexts –

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[1] For every arbitrary X, Y: iff $f(X \cap Y) \Leftrightarrow f(X) \cup f(Y)$ and $f(X \cup Y) \Leftrightarrow f(X) \cap f(Y)$, then the function f is anti-morphic; iff $f(X \cup Y) \Leftrightarrow f(X) \cap f(Y)$, then the function f is anti-additive. These definitions are adapted from Van der Wouden (1994).

as proved by Zwarts – stand in a subset relationship with each other. For instance, all anti-morphic environments are anti-additive and DE, but not vice versa. In the context of the Dutch NPI, it is relevant to know the following. First, the sentential negative marker *niet* is anti-morphic. Second, negative indefinites such as *niemand* are anti-additive but not anti-morphic. Finally, semi-negative expressions such as *nauwelijks* and exclusive adverbs such as *alleen* are merely DE.[2]

3. Experiment

3.1. Method

In order to access children's acquisition of the Dutch NPI *hoeven*, we carried out an elicited imitation task. In an elicited imitation task, participants are required to first listen carefully to (pre-recorded) stimuli and then repeat the stimuli as exactly as they heard it (Lust et al. 1996, Vinther 2002). When repeating a stimulus as precisely as was heard, participants are claimed to construct their own mental representation of it according to their own grammatical system established so far (Chomsky 1964, Eissenbeiss 2010, Keenan and Hawkins 1987, Panitsa 2001, Scholl and Ryan 1980). If a stimulus is in agreement with their own grammar, participants repeat the stimulus immediately after hearing it (Scholl and Ryan 1980); whereas they correct it in accordance with their own grammar, or do not repeat the stimulus if it is ungrammatical based on their grammar of the target language (Brown 1973, Keeney and Wolfe 1972, Vinther 2002).

3.2. Conditions

The experiment included five DE-operators, which license the Dutch NPI *hoeven*: *niet* 'not' (four stimuli), *geen* 'no(ne)' (two stimuli), *niemand* 'nobody' (two stimuli), *weinig* 'few' (two stimuli), and *alleen* 'only' (two stimuli). All these five operators are acquired by children around age three (Van der Wal 1996: Table 4.1). The reason for this selection was that they represent different types of DE-contexts: *niet* is anti-morphic; *geen* and *niemand* are anti-additive; *weinig* and *alleen* are only DE (cf. Section 2). This manipulation enabled us to explore the contribution of the semantic knowledge of various negative contexts to the acquisition of the NPI. In order to examine whether children are aware of the ungrammaticality of *hoeven* in simple affirmative contexts, we added four ungrammatical stimuli by placing *hoeven* in sentences like (3).

In addition to the six test conditions described above, the experiment also had filler conditions containing a total of twenty fillers. As to neutralise the effect that every test stimulus contained the same modal verb *hoeven*, half of the fillers were designed with a modal verb as well, of which six involved *willen* 'will' and four involved *kunnen* 'can'. Both *willen* and *kunnen* are polarity-insensitive: they are neither NPIs like *hoeven* nor PPIs (Positive Polarity Items) like *moeten* 'must' (cf. Iatridou and Zeijlstra 2013). Since the majority of the test stimuli containing the NPI *hoeven* were negative, half of the fillers were manipulated to be negative as well.

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[2] We follow von Fintel (1999) and analyse exclusive adverbs as a specific kind of DE-operator: Strawson-DE, which he defines by making use of presuppositions.

Moreover, four out of the twenty fillers were ungrammatical. They all contained a syntactic error due to a non-application of the V2 rule in Dutch main clauses. An example is given below. We added these ungrammatical fillers to counterbalance the (un)grammaticality of the stimuli.

(4) *Gisteren Jan met   Marie in   het   park   wandelde.
     yesterday Johnwith Mary in   the   park   walked
     Intended: 'Yesterday, John walked in the park with Mary.'

3.3. Stimuli

In an elicited imitation task, the length of stimuli must be controlled (Montgomery et al. 1978, among others) as to prevent children from giving a repetition response from memory alone without first establishing their own mental representations of stimuli. Stimuli need to be long enough to override children's working memory capacity but short enough for comprehension because children must construct their own mental representations of them without omitting too many words. All of the test and filler stimuli in the current experiment contained ten words. This represents a medium length of stimuli according to Montgomery et al. (1978), which is neither too short nor too long for participants between age four and six.

Words appearing in the stimuli are attested in daily communication with children under age five. The stimuli only contained main clauses to ensure a similar syntactic complexity. Some examples of our stimuli are given below: (5) represents the licensing conditions by *niemand*; (6) is an example of unlicensed *hoeven*. Two examples of grammatical fillers – one with a modal and the other without – are given in (7a) and (7b), respectively.

(5) Vandaag hoeft   Beer   aan   niemand   een   potje   honing te   geven.
     today   needs   Pooh   to   nobody   one   jar   honey to   give
     Lit. 'Pooh needs to give nobody a jar of honey today.'
     'Pooh does not need to give anybody a jar of honey today.'

(6) *Beer   hoeft   samen   met   zijn   vriendjes mooie liedjes te   zingen.
     Pooh   needs   together with his   friends   nice   songs to   sing
     Intended: 'Pooh needs to sing nice songs together with his friends.'

(7) a.   Met   het slechte   weer   wil Beer niet   naar   buiten   gaan.
          with   the bad   weather will Pooh not   to   outside go
          'Pooh will not go outside with the bad weather.'
     b.   Met   het koude weer   draagt Beer alleen   een   blauwe   sjaal.
          with   the cold   weather wears Pooh only   a   blue   scarf
          'With the cold weather, Pooh only wears a blue scarf.'

The stimuli were pre-recorded in an MP3 recorder by a female native Dutch speaker. To minimise prosodic influence, the speaker recorded the stimuli as neutrally as possible. The presentation order of the stimuli was counterbalanced.

3.4. Categorisation of responses

Children's responses to the stimuli were divided into three main categories: *no response*, *imitation response*, and *non-imitation response*. The category of *no response* referred to the instances in which the child either did not give any response at all after hearing a stimulus or gave an irrelevant response such as *Heb 'm niet gehoord* 'I didn't hear it'.

A response was categorised as *imitation* when the participants imitated the stimuli. However, as the stimuli length was controlled such that the participants needed to first establish their own mental representations of the stimuli, it was hardly ever the case that the participants were able to repeat every single word in a stimulus. We thus focused only on how the participants reacted to the licensing of *hoeven* and defined *imitation* as follows. It referred to responses in which at least both the NPI *hoeven* and the manipulated licenser were repeated in the manipulated order.

The category of *non-imitation responses* was further divided into three subcategories: *substitution*, *omission*, and *addition*. Consider the test stimulus in (5) as an example. An instance of *substitution* was counted if the child substituted the manipulated licenser *niemand* with another licenser, e.g., *niet* in (8a); substituted the NPI with another verb, e.g., *gaat* 'goes' in (8b); or substituted both the NPI and the manipulated licenser by an alternative, as shown in (8c).

(8) a. Vandaag hoeft Beer niet   aan iemand   een   potje honing te   geven.
         today   needs Pooh not   to somebody one   jar   honey to   give
         'Pooh does not need to give a jar of honey to anybody today.'
     b. Vandaag gaat Beer   aan   niemand   een   potje honing geven.
         today   goes Pooh   to   nobody   one   jar   honey give
         Lit. 'Pooh is going to give nobody a jar of honey today.'
         'Pooh is not going to give anybody a jar of honey today.'
     c. Vandaag gaat Beer   niet   aan   iemand   een   potje honing geven.
         today   goes Pooh   not   to   somebody one   jar   honey give
         Lit. 'Pooh is going to give nobody a jar of honey today.'
         'Pooh is not going to give anybody a jar of honey today.'

A *non-imitation response* was categorised as *omission* if the child omitted the NPI as in (9a); left out the manipulated licenser as in (9b); or omitted both of them as in (9c).

(9) a. Vandaag Beer   aan   niemand   een   potje honing geven
         today   Pooh   to   nobody   one   jar   honey give
         'Pooh give nobody a jar of honey today'

   b.   *Vandaag hoeft   Beer   een   potje   honing te   geven.
        today   needs Pooh   one   jar   honey to   give
        Intended: 'Pooh needs to give somebody a jar of honey today.'
   c.   Vandaag Beer   een   potje   honing geven
        today   Pooh   one   jar   honey give
        'Pooh give (somebody) a jar of honey today'

A *non-imitation response* was categorised as *addition* if the child gave a grammatical response by adding a licenser for the NPI while confronted with a stimulus containing unlicensed *hoeven*. For example, an instance of *addition* was counted if the child gave (10) as a response to the ungrammatical stimulus (6), by adding *niet* to license the NPI.

(10) Beer   hoeft niet samen   met zijn vriendjes mooie   liedjes   te   zingen.
      Pooh   needs not   together   with his friends   nice   songs   to   sing
      'Pooh does not need to sing nice songs together with his friends.'

3.5. Participants & Procedure

A total of 133 typically developing monolingual Dutch children (2;09–5;10; M = 4;04; SD = 9.3 months) recruited via day care centres and elementary schools in the Netherlands participated in the experiment. The experiment was conducted individually and took place at educational institutions. The procedure of the experiment was as follows. We first invited a child from a class for a game and then explained how the game would proceed and what we expected him or her to do. There were four trials for each child to become familiar with the experimenter and the experiment. If the child proved to understand what was expected of him or her after the trials, the experiment started. The experiment lasted an average of fifteen minutes for the four-year-olds, while the younger participants took five minutes more on average.

Two experimenters were present during the experiment. While one experimenter tested the child, the other experimenter filled in a score sheet, and recorded the child's responses on an MP3 recorder for later transcription and analysis.[3]

4. Results

In order to model the acquisitional pathway of the Dutch NPI *hoeven*, we employed a general linear mixed-effect logistic regression analysis in R for each of the six test conditions. We assigned the value of 1 to all *imitation responses* and 0 to all *non-imitation* responses as well as in cases of *no response*. With the ages of the participants as the independent variable and their repetition scores (0 or 1) as the dependent variable, the regression analyses conducted on our cross-sectional data enabled us to generalise the developmental patterns of children's knowledge

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[3] In the score sheet, the experimenter assigned the child's responses to different categories and wrote down critical changes or corrections in the responses, when applicable.

of the NPI in different conditions. Results of the regression analyses are presented in the graph below.[4] The x-axis represents the participants' age in terms of months, the y-axis indicates the repetition probability of the stimuli predicted by the regression models, and the interpolation line represents the mean value of the predicted repetition probabilities.
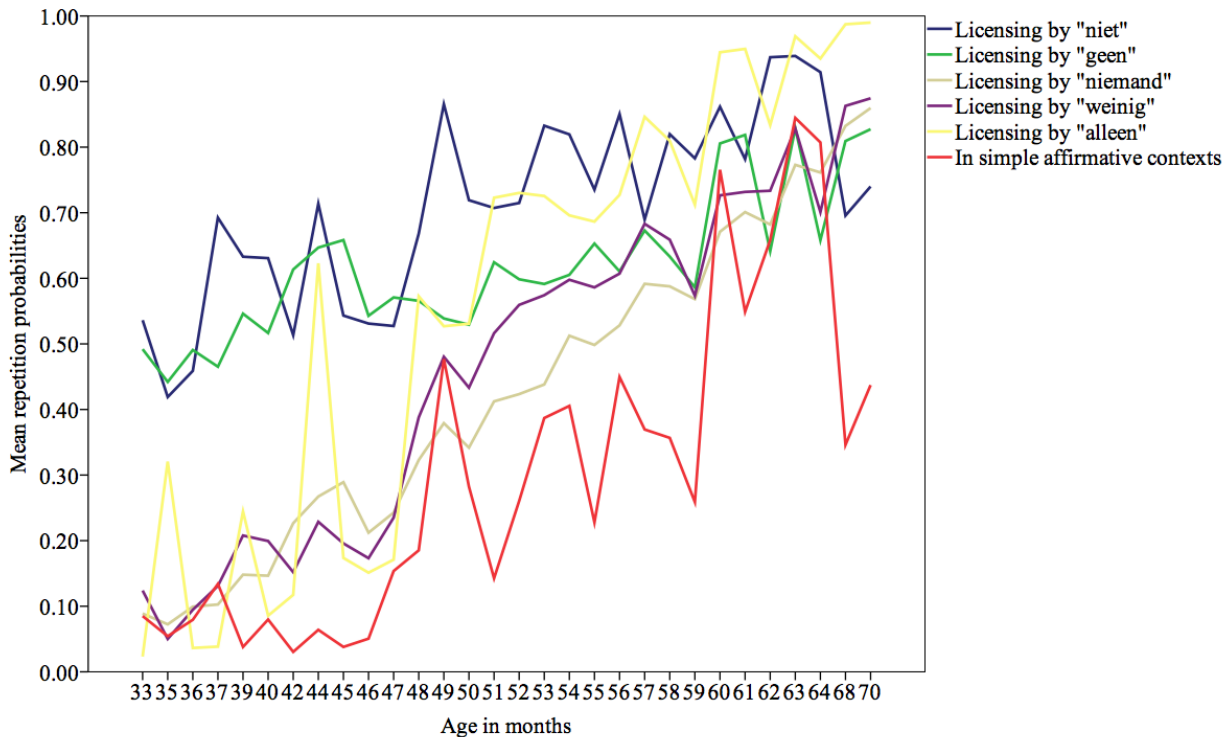
Figure 1: The development of children's knowledge of *hoeven* licensing over time

We start with the licensing condition by the sentential negative marker *niet*. As illustrated in Figure 1, children are predicted to give a repetition response in this test condition around 50% of the time at younger ages, i.e. below 3;04 (i.e. 40 months). However, our regression model attests a significant age effect in the development ($p < .001$), which means that children's repetition performance improves significantly with age. In particular, at 5;00 (i.e. 60 months) and older, the predicted probabilities for children's repetition behaviour reach .90 on average.

In the licensing condition by the negative indefinite *geen*, our regression model predicts a similar developmental pattern. Children younger than 3;04 (i.e. 40 months) are predicted to be able to give imitation responses around 50% of the time and that their performance slightly improves when they are older. For instance, at 5;10 (i.e. 70 months), the predicted probabilities reach .80. Moreover, the improvement in children's repetition performance is significant ($p = .00313$).

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[4] One of the 133 children was removed from our dataset because she never repeated the NPI *hoeven* in her responses, regardless of its licensing environments.

In the licensing condition by *niemand*, *weinig*, or *alleen*, however, our regression models predict a distinct acquisitional path. Instead of a starting value at around .50 attested in the licensing condition by *niet* or *geen*, children's repetition probabilities are merely around .10 at 3;04 or younger in the licensing condition by *niemand*. Nevertheless, children's repetition performance significantly increases as they grow older ($p < .001$): at 5;10 and older, they are predicted to be able to repeat the stimuli in this licensing condition approximately 90% of the time.

Children's knowledge on *hoeven* licensing by the DE-operator *weinig* exhibits a similar growth as their knowledge on the licensing of the NPI by *niemand*. When confronted with stimuli containing *hoeven* licensed by *weinig*, children below 3;10 (i.e. 46 months) give a repetition response merely 15% of the time on average, whereas their older counterparts show better imitation performance. For instance, at 4;09 (i.e. 57 months), children's repetition probabilities are around .70; and at 5;10 (i.e. 70 months), they reach .90. In this licensing condition, children's repetition performance significantly improves with age as well ($p < .001$).

With respect to the licensing condition by the exclusive adverb *alleen*, our regression model predicts the following. Between 2;09 (i.e. 33 months) and 3;06 (i.e. 42 months), children's repetition probabilities are around .10, which significantly increase ($p < .001$) and reach 1.0 at 5;03 (i.e. 63 months). The significant increase suggests a substantial growth in children's grammatical knowledge on the licensing of *hoeven* by the exclusive adverb *alleen*.

The regression results summarised above strongly suggest two kinds of developmental patterns in acquisition, distinguishable when we consider the starting values of the predicted probabilities of children's repetition performance. One pattern covers children's development in the licensing condition by *niet* or *geen*. In both these licensing conditions, our models predict a repetition probability of at least .50 at 2;09, which increases to .90 and .80, respectively, at 5;10. Another pattern signifies the development in the licensing condition by *niemand*, *weinig*, or *alleen*. Although in these licensing conditions, our models predict a repetition probability of at least .90 at 5;10, as well as for the licensing condition by *niet* or *geen*, the starting values of the imitation probabilities are merely .10 in the licensing condition by *niemand* or *weinig* and even less than .05 in the licensing condition by *alleen*.

Recall the rationale of an elicited imitation task that children are only able to repeat a stimulus if it is in line with their own grammatical system. The two developmental patterns described above thus represent the following learning path of the Dutch NPI from the ages of approximately three to six. Children start out with a strict grammar that only generates *hoeven*'s appearance in the scope of the sentential negative marker *niet* or the negative indefinite *geen* and further develop their grammar towards an adult-like direction such that the grammar at later ages also allows the NPI to be licensed by other DE-operators, namely *niemand*, *weinig*, and *alleen*. In the next section, we will explore what early and late child grammar of the NPI may consist of such that they generate the distribution of *hoeven* in language development as observed in our experiment.

We now move on with the development predicted by the regression model for the unlicensed test condition, which is presented in Figure 1 as well. At first sight, the development in this test

condition seems to exhibit a similar path as that in the licensing condition by *niemand*, *weinig*, or *alleen*. In these four test conditions, the repetition probabilities are predicted to be extremely low at 2;09 (i.e. 33 months) but increase to at least .80 at 5;04 (i.e. 64 months). Nonetheless, the development in the licensing conditions by *niemand*, *weinig*, and *alleen* are all akin to a linear pattern, whereas the development in the unlicensed test condition appears to be much less linear but rather exhibits three stages. In particular, between 2;09 and 4;00, the predicted probabilities of the repetition performance are merely .08 on average, which nevertheless increase to approximately .47 between 4;00 and 5;00, and to around .68 after 5;00. In the discussion we will come back to this point and demonstrate that the difference with respect to the linearity observed here represents different reasons underlying the increase in children's repetition scores. We will argue for an explanation based on older children's better working memory capacity.

5. Analysis

The regression results presented in Section 4 strongly suggest a two-stage development of children's knowledge on the licensing of the Dutch NPI *hoeven*. Younger children (two- and three-year-olds) are only able to repeat stimuli in the licensing conditions by *niet* and *geen*, whereas their older counterparts also show good repetition performance in the licensing conditions by *niemand*, *weinig* and *alleen*. This section explores how the knowledge on *hoeven* licensing may be presented in the grammar of children at different ages such that it generates the developmental pattern of the NPI as observed in our experiment.

5.1. *Hoeven* in early child grammar

As our regression results show, Dutch two- and three-year-olds are only able to repeat the stimuli in the licensing conditions by *niet* and *geen*, but not those in which *hoeven* is licensed by *niemand*, *weinig*, or *alleen*. Given the rationale of elicited imitation tasks (cf. Section 3), we interpret such results as evidence that children below age four have only acquired that the NPI is allowed to appear in the scope of the sentential negative marker *niet* or the negative indefinite *geen*. Moreover, as a similar development is predicted for the licensing conditions by *niet* and *geen*, namely that children are predicted to be able to repeat the stimuli in both conditions already 50% of the time on average at 2;09 and at least 80% of the time at 5;04, or older, we further hypothesise a similar kind of knowledge underlying *hoeven*'s appearance in the scope of *niet* or *geen* in early child grammar.

Following a distributional approach proposed for category learning (Cartwright and Brent 1997, Mintz et al. 1995, 2002, Mintz 2002, Redington et al. 1998), we assume that children's analysis of their target language at initial stages is input-based only. We therefore consulted the distribution information of *hoeven* in the language input in order to explore how the NPI may be represented in grammar of Dutch children at younger ages.

As reported in Lin et al. (2015), in the language input, the NPI *hoeven* co-occurs with the sentential negative marker *niet* 80.8% of the time (299 out of 370), and with the negative indefinite *geen* 10.8% of the time (40 out of 370). More interestingly, *hoeven*'s co-occurrence

with *niet* or *geen* is either adjacent, or near-adjacent, for instance, within a distance of three syllables (see a relevant discussion in Lin et al. 2015). Adopting the distribution-based learning approach (Mintz 2002, 2003, Mintz et al. 2002), we hypothesis that Dutch children establish a lexical dependency between the NPI on the one hand and *niet* or *geen* on the other when they are confronted with the massive (near-) adjacent co-occurrence of *hoeven* with these two negative forms in the language input. We further hypothesise that this lexical dependency is represented by two lexical frames [HOEF NIET] and [HOEF GEEN] in children's mental lexicon. Assuming that these lexical frames are part of children's lexical knowledge and are retrieved in the same way as single lexical items, it logically follows that Dutch children at younger ages are already able to give repetition responses to the stimuli in both the licensing conditions by *niet* and *geen*. This is exactly what our experimental results show (cf. Figure 1). We therefore conclude that the early child grammar of the Dutch NPI consists of two lexical frames: [HOEF NIET] and [HOEF GEEN].

A critical reader may however raise the question of why children at younger ages, for instance, below the age of four, are only able to repeat the stimuli in the relevant licensing conditions only around 50% of the time (see again Section 4). If the two lexical frames indeed form part of children's lexical knowledge, shouldn't we expect (much) higher repetition probabilities in these two test conditions once children have established this knowledge? We hypothesise here a possible confounding factor that may hinder (much) better imitation performance of younger children in general but is irrelevant to their knowledge of the licensing of the NPI *hoeven*.

As to investigate this confounding factor, we compared younger children's repetition performance in the two relevant licensing conditions with their performance when confronted with filler stimuli containing a polarity insensitive modal verb, i.e. *kunnen* 'can' or *willen* 'will', with or without negation. Such filler stimuli share the same syntactic structure as our test stimuli. In particular, both types of stimuli involve two verbs: a modal verb – *kunnen*, *willen*, or *hoeven* – and a generic lexical verb such as *geven* 'give', *oprapen* 'pick up', or *zingen* 'sing'. The average repetition rates of children under the age of four when confronted with different test and filler stimuli containing both a modal and a lexical verb are provided in Table 1. Here the criteria mentioned in Section 3 are maintained as well: *imitation responses* refer to instances in which at least the manipulated modal verb and the manipulated negation – if applicable – were repeated.

Condition	Manipulation	Repetition rate	Number of responses
Test	*hoeven* licensed by *niet*	48.1%	108
	hoeven licensed by *geen*	51.9%	54
Filler	*kunnen* in affirmative contexts	43.2%	83
	kunnen in the scope of *niet*	59.3%	54
	willen in affirmative contexts	48.1%	81
	willen in the scope of *niet*	56.8%	81

Table 1: Average repetition rates of two- and three-year-olds in the licensing condition by *niet* and *geen*, and in the filler condition containing *kunnen* or *willen*

Data reported in the table above show that Dutch two- and three-year-olds exhibit similar rates of repetition when confronted with stimuli containing two verbs – a modal verb and a lexical verb –

irrespective of whether the manipulated modal verb was the NPI *hoeven*. A further analysis of these data confirms that there is no significant difference between younger children's repetition performance in the different test and filler conditions ($F(5,439) = .712$, $p = .615$). Even when we only focus on the filler stimuli containing *kunnen* or *willen* in the scope of marker *niet*, which means that the only difference between these filler stimuli and the relevant test stimuli is the modal verb, we do not find any significant difference ($F(3,285) = .446$, $p = .720$).

These results suggest that younger children's relatively low repetition rates in the above-listed test and filler conditions do not have any indication for how *hoeven* is represented in early child grammar or how it is retrieved from children's lexicon. Children's imitation probabilities around 0.50 at younger ages are rather explained by a factor, which is irrelevant to (children's knowledge on) the licensing of the NPI. Arguably, two- and three-year-olds' poor working memory capacity may hinder better repetition performance (cf. Montgomery et al. 1978, see also Eisenbeiss 2010). In addition, it may be that stimuli containing two verbs (a modal and a lexical verb) are difficult to process and produce for children below the age of four, resulting in their poor repetition performance in the relevant licensing and filler conditions.

5.2 *Hoeven* in late child grammar

Compared to younger children, who only show relatively good imitation performance in the licensing condition by *niet* or *geen*, their older counterparts exhibit good repetition performance in all of the five manipulated licensing conditions. In particular, older children do not only repeat the stimuli containing the NPI in the scope of *niet* or *geen*, but they also give imitation responses to the stimuli in which *hoeven* is licensed by the other manipulated DE-operators: the negative indefinite *niemand*, the semi-negative quantifier *weinig*, and the exclusive adverb *alleen*. Since these are all possible licensers for the NPI in adult language use, the results obtained with older children indicate a development of an analysis of the NPI in an adult-like direction.

The most straightforward way to account for older children's analysis of the NPI is to follow the input-based learning approach, and to hypothesise that Dutch four- and five-year-olds have established three more lexical frames in addition to [HOEF NIET] and [HOEF GEEN] constructed at younger ages, namely [HOEF NIEMAND], [HOEF WEINIG], and [HOEF ALLEEN]. However, the input-based approach does not turn out to be an adequate learning mechanism at late stages. The investigation of the distribution of *hoeven* in the input by Lin et al. (2015) shows that the NPI is extremely infrequently attested with *niemand*, *weinig*, or *alleen*. *Alleen* licenses the NPI around 0.1% of the time (4 out of 370); *niemand* or *weinig* is even never attested as licenser of *hoeven*. Given the extremely infrequent co-occurrence of the NPI with these DE-operators, it appears unlikely that Dutch four- and five-year-olds may establish the corresponding lexical frames on the basis of the same distribution-based learning approach as their younger counterparts do.

An alterative explanation is to assume that older children have developed an analysis of the NPI via a learning mechanism that does not require massive co-occurrence of *hoeven* with the three DE-operators (*niemand*, *weinig*, and *alleen*) in the language input. But what may this analysis of *hoeven* consist of?

Here we adopt a decomposable analysis of negative indefinites in languages such as Dutch (cf. Jacbos 1980, see also Rullmann 1995, Zeijlstra 2011), namely that they are decomposed into both an abstract negation NEG and an existential quantifier. Such a decomposable analysis can be illustrated for *niemand* as follows.

(11) *niemand* 'nobody'

NEG   *iemand* 'somebody'

The decomposable analysis as exemplified above applies to the negative indefinite *geen* (NEG-one) as well; it moreover applies to other negative expressions, for instance, the semi-negative quantifier *weinig* (NEG-many), and the exclusive adverb *alleen* (NEG-other than) (von Fintel and Iatridou 2003, Iatridou and Zeijlstra 2013, Penka 2011, Penka and Zeijlstra 2005). This means that the DE-operators that are not anti-morphic manipulated in our experiment all contain a decomposable, abstract negation NEG.

The incorporation of the abstract negation NEG into the DE but not anti-morphic operators employed in the current experiment provides us the possibility to assume that Dutch four- and five-year-olds establish a lexical dependency between the NPI *hoeven* on the one hand and the abstract NEG on the other. We further assume that this lexical dependency is realised as [HOEF NEG] (cf. Postal 2000). The analysis [HOEF NEG] demonstrates how the Dutch NPI is underlyingly represented in late child grammar, and generates *hoeven*'s occurrence in the scope of different DE-operators that contain the decomposable negation NEG. As this NEG can also be phonologically realised by the sentential negative marker *niet*, the abstract analysis [HOEF NEG] gives rise to *hoeven*'s appearance in anti-morphic contexts as well. Thus, the assumption of one single abstract analysis [HOEF NEG] explains why older children show good imitation performance in all of the five manipulated test conditions – even when confronted with *hoeven* licensed by extremely infrequently used DE-operators in the input.

The analysis that *hoeven* in late child grammar has a lexical dependency with the abstract negation NEG, represented as [HOEF NEG], in fact requires children's syntactic knowledge of the decomposable analysis of the DE-operators as exemplified in (11). This, however, raises two questions. First, how do we know that Dutch children have already acquired the decomposable analysis of the relevant DE-operators before reanalysing the NPI *hoeven* as [HOEF NEG]? Second, how do Dutch children develop the abstract analysis [HOEF NEG] after their construction of the two lexical frames based on input frequency only at younger ages?

The decomposable analysis of the DE-operators is evident when they are assigned a so-called split-scope interpretation if they are used together with a modal verb, for instance. Consider an example in this respect in (12), which has three readings. One reading is a narrow scope reading, which is marginally available, illustrated in (12a). Here the abstract negation NEG together with

the existential quantifier *iemand* 'somebody' is interpreted in the scope of the modal verb *mag* 'may'. A second reading is a wide scope reading, see (12b), in which the abstract negation NEG and the existential quantifier *iemand* together scope over the modal verb *mag*. A third reading that is available here is the split-scope reading – the most salient reading of sentences like (12). Here the abstract negation NEG scopes over *mag* whereas *mag* in turn takes scope over the existential quantifier *iemand*, see (12c).

(12) Jan   mag   niemand   zoenen.
      John   may   nobody   kiss
      a. 'John is allowed to kiss nobody.'   may>NEG>somebody
      b. 'There is no specific person that John is allowed to kiss.'   NEG>somebody >may
      c. 'It is not the case that John is allowed to kiss anybody.'   NEG>may>somebody

Analysing spontaneous speech data of Dutch children in the CHILDES database (MacWhinney 2009), Lin et al. (2015) find that Dutch two- and three-year-olds systematically use negative indefinites (i.e. anti-additive and DE-operators) such as *geen* or *niemand* in a context in which a split-scope reading is available and the most salient one. These data suggest that Dutch children have already acquired the decomposable analysis of (at least some of) the DE-operators manipulated in the current experiment. This supports the hypothesis that older children reanalyse the NPI as lexically associated with the abstract negation NEG, represented as [HOEF NEG].

We moreover assume that the acquisition of the decomposable analysis of the negative indefinite *geen* plays a crucial role in a sense that it helps children to develop the abstract, generalisable analysis [HOEF NEG] after their construction of the two lexical frames [HOEF NIET] and [HOEF GEEN] at younger ages. In particular, having acquired that *geen* contains a decomposable abstract negation NEG helps children to realise what [HOEF NIET] and [HOEF GEEN] share in common. Given that the abstract negation NEG can also be spelled-out as the sentential negative marker *niet*, what the two lexical frames share is that they both require a lexical association between *hoeven* and NEG. This enables older children to develop [HOEF NEG], the abstract, generalisable analysis, from the previously established concrete frames [HOEF NIET] and [HOEF GEEN].

We now proceed with presenting two pieces of evidence for the assumption of the generalisable, abstract analysis [HOEF NEG] in late child grammar. First, there are similarities when we look at the development of children's imitation performance in the licensing conditions by *niemand*, *weinig*, and *alleen* – three DE-operators that are extremely infrequently attested as licenser of *hoeven* in the language input. For these licensing conditions, our regression models predict a gradual acquisitional process in which the predicted repetition probabilities increase from (lower than) .10 at 2;09 (i.e. 33 months) to at least .80 on average at 5;06 (i.e. 66 months) (see again Figure 1). Although the predicted probabilities in the licensing condition by *alleen* turn out to have larger individual differences when children are younger than 4;02 (i.e. 50 months) (SD = 0.355) than those in the licensing condition by *niemand* (SD = 0.230) and *weinig* (SD = 0.263), the general developmental tendency observed for these three licensing environments is obvious.

The developmental similarities described above provide evidence for the hypothesis of the abstract analysis [HOEF NEG] in late child Dutch. *Hoeven*'s appearance in the scope of *niemand*, *weinig*, or *alleen* is not generated by the two lexical frames [HOEF NIET] and [HOEF NEG] established at early stage. Therefore, younger children show extremely poor imitation performance in the licensing conditions by *niemand*, *weinig*, or *alleen*. After age four, children are assumed to have developed the abstract analysis [HOEF NEG], which generates *hoeven*'s occurrence in the scope of all the three relevant DE-operators since they can each be analysed as containing the abstract but decomposable negation NEG. This accounts for the significant increase in children's repetition probabilities in all these three licensing conditions, and explains why the development of children's knowledge of *hoeven* licensing by the infrequent licensers proceed simultaneously.

The assumption that the late child grammar contains merely one single abstract and generalisable analysis [HOEF NEG] is further confirmed when we look at the correlations among the repetition probabilities in each of these licensing contexts. The correlation data are given below.

Licenser	*niemand*	*Weinig*	*alleen*
niemand	1.00		
weinig	0.88 ($p < .000$)	1.00	
alleen	0.81 ($p < .000$)	0.83 ($p < .000$)	1.00

Table 2: Correlation coefficients among children's performance in the licensing condition by *niemand*, *weinig*, or *alleen*

As presented in the table, there are significantly strong correlations among children's repetition performance in these three licensing conditions. These correlation data suggest that *hoeven*'s appearance in the scope of *niemand*, *weinig*, or *alleen* has exactly the same status in child grammar. Given the learning path hypothesised in this subsection, this same status amounts to *hoeven*'s occurrence in the corresponding licensing conditions being generated by one and the same analysis. This provides evidence for the existence of the abstract analysis [HOEF NEG] in late child Dutch.

The above-reported correlation data also has an implication for Zwarts' theory of polarity licensing (cf. Zwarts 1981, 1986, 1995). As introduced in Section 2, negative contexts – which are DE-contexts in terms of Ladusaw (1979) – are categorised into three types depending on their logico-semantic behaviours: anti-morphic, anti-additive, and DE-contexts. Such a categorisation, however, does not turn out to be crucial or necessary for the acquisition of the Dutch NPI, given what we have observed in the current experiment. The negative indefinite *niemand* is an anti-additive operator, whereas *weinig* and *alleen* are both only DE. This categorial difference is nevertheless not reflected in the pace or pattern of the development of children's knowledge on *hoeven*'s appearance in the scope of these licensers. The development predicted by our regression models for the licensing conditions by *niemand*, *weinig*, and *alleen* is rather strongly correlated. In spite of the logico-semantic difference between the anti-additive operator *niemand* and the DE but not anti-additive operators *weinig* and *alleen*, children show a similar learning path in all three licensing conditions (cf. Figure 1).

On top of this, we also find that the correlation between the repetition behaviour in the licensing conditions by *geen* and *niemand* is much weaker (r = .48, *p* < .000). Since both *geen* and *niemand* are anti-additive, we would expect a much stronger correlation – if the notion of anti-additivity indeed played a crucial role in the acquisition of the NPI *hoeven*.

Taken together, the correlation results lead to the conclusion that the distinction between notions such as anti-additivity or downward entailment is irrelevant to the acquisition of the Dutch NPI. Lin et al. (2015: Appendix 2) already illustrate that the abstract negation NEG gives rise to a restricted distributional pattern of the NPI as is empirically observed with Dutch native speakers. We therefore conclude that semantic notions such as anti-additivity or downward entailment are irrelevant to the licensing of this particular NPI either. Given the abstract analysis [HOEF NEG], emerged as a result of language acquisition, we argue that *hoeven* is only allowed to appear in DE-contexts that incorporate this abstract negation, because of its lexical dependency with the abstract negation NEG (cf. Postal 2000). This in turn may explain the distributional difference between the Dutch NPI and English *any*-terms as introduced at the beginning of the paper.

6. Discussion & Conclusion

Above we hypothesised a two-staged development of how Dutch children acquire the NPI modal verb *hoeven*, in which they start out with two lexical frames [HOEF NIET] and [HOEF GEEN] at initial stages, and develop one single abstract analysis [HOEF NEG] later on. Before drawing any conclusion, we would like to first discuss children's repetition performance attested in the test condition in which *hoeven* appears in simple affirmative contexts. We will argue for an explanation based on children's working memory capacity.

Recall the repetition performance in the unlicensed test condition predicted by our regression model: between 2;09 and 4;00, the repetition probabilities are merely .08, which increase to approximately 0.47 between 4;00 and 5;00, and further increases to around 0.68 after 5;00. At first sight, the improvement in children's repetition performance when confronted with *hoeven* in simple affirmative contexts seems to suggest a development towards a non-adult-like direction. In particular, it seems that children are developing a tolerant grammar, which even allows *hoeven* to appear in the absence of a licenser – although they start out with a much narrower analysis of *hoeven* that restricts it to co-occur with *niet* or *geen* only.

We argue here that the increase in children's repetition probabilities in the unlicensed test condition does not represent a change in children's knowledge on *hoeven* licensing towards a non-target-like direction but is rather explained as a consequence of older children's better working memory capacity. As mentioned in Section 3, the length of stimuli is crucial to children's behaviours in an elicited imitation task. To ensure that children (re)construct their own mental representation of stimuli based on their own grammar but do not give a repetition of stimuli from memory alone, stimuli must be sufficiently long to override children's memory capacity. Nevertheless, to be able to compare the performances of our participants of different ages, we opted for a unified stimuli length of ten words – a medium length of stimuli according

to Montgomery et al. (1978). If we assume that the working memory capacity of our participants – who were all typically developing – increases with age, it is not impossible that the length of ten words was just too short for the four- and five--year-olds to override their better working memory capacity compared to their younger counterparts. This may result in the unexpected improvement in their repetition performance in the unlicensed test condition.

The above hypothesised explanation may account for the difference with respect to the linearity of the development observed for the licensing conditions by *niemand*, *weinig*, and *alleen* on the one hand, and that attested for the unlicensed test condition on the other, although the developments predicted by our regression models for all four test conditions seem to have a similar starting value at the age of 33 months. The unlicensed test condition demonstrates a more stage-like development, whereas the development in the licensing conditions by *niemand*, *weinig*, and *alleen* are all akin to a linear growth pattern (cf. Figure 2). The difference with respect to the linearity may represent different reasons underlying the improvement attested in children's repetition performance. However, our experiment did not contain any procedure for examining the participants' working memory. This calls for further research in this respect.

To conclude, the experimental results obtained with 132 monolingual Dutch children in an elicited imitation task suggest an acquisitional path as follows. Children start with a strict grammar that only allows *hoeven* to appear in the scope of either the sentential negative marker *niet* or the negative indefinite *geen*, represented by two lexical frames [HOEF NIET] and [HOEF GEEN] in early child grammar, but later switch to a less strict grammar that allows *hoeven* to appear in a wider set of DE-contexts, namely those introduced by *niemand*, *weinig*, or *alleen*, represented by [HOEF NEG] in late child language. Since [HOEF NEG] is the analysis of the Dutch NPI emerged as the result of language acquisition, we conclude that *hoeven* is an NPI because it has a lexical dependency with the abstract negation NEG (cf. Postal 2000). Our experimental results also lead to the conclusion that semantic notions such as anti-additivity or downward entailment is irrelevant to the acquisition of NPIs such as *hoeven*, which exhibit a narrower distribution than NPIs like *any*-terms. Moreover, our exploration of the acquisition of the Dutch NPI strongly suggest that the acquisition of NPIs like *any* cannot and must not show the same learning pathway as that detected for the Dutch NPI *hoeven*. The reason is twofold: on the one hand, input evidence differs from language to language, and from NPI to NPI; on the other hand, an analysis such as [ANY NEG] does not generalise the target distribution of *any*.

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Behavior-related unergative verbs[1]

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Abstract. In languages such as French, it is possible to derive from common or proper nouns unergative verbs that intuitively describe ways of behaving, for example, *diplomatiser* 'behave like a diplomat'. This paper focuses on the semantics of these verbs, in particular, on the semantic contribution of the incorporated noun, by looking at the entailment patterns between the verb (e.g. *diplomatiser* 'behave like a diplomat') and the corresponding noun (e.g. *être (un/une) diplomate* 'be a diplomat'). The analysis proposed explicitly captures the figurative reading of *être un/une diplomate* 'be a diplomat', the link between the meaning shift of N in this reading and in *diplomatiser* 'behave like a diplomat', as well as the entailment patterns observed.

Keywords: behavior-related verb, unergative verb, bare noun, indefinite NP, stereotype, figurative reading, lexical semantics.

1. Introduction

We call *behavior-related verbs* unergative verbs that intuitively describe ways of behaving. Nouns and adjectives which behavior-related verbs are derived from may be used to describe dispositional properties of individuals, as seen by the French examples in (1). Verbs derived from such nouns and adjectives describe actualizations of these dispositional properties, as in (2).

(1) a. [...] mon doudou **est un vrai lézard**. Il adore se prélasser sous le soleil.   (Internet)
      'My honey is a true lizard. He loves basking under the sun.'
   b. Juliette **est une vraie diplomate** !
      'Juliette is a true diplomat!'
   c. À propos de sa fille, Carla Bruni déclare [...] « Elle **est très Sarkozy**. Nicolas a trouvé son maître. »   (Internet)
      'About her daughter, Carla Bruni declares [...] "She's very Sarkozy. Nicolas found his master." '
   d. Comme d'habitude, [DSK] **était pédant**.   (Internet)
      'As usual, [DSK] was pedantic.'

(2) a. On le dit aux bains de mer, quelque part, où il **lézarde** et flirte.   (Colette)
      'One says he's at a seaside resort, somewhere, where he's lazing around and flirting.'
   b. On **diplomatise**, on discutaille, et les autres ils continuent d'implanter des colonies.
      (Internet)

'One diplomatizes, one quibbles, while the others continue to set up colonies.'

   c.   Les spasmes financiers tenaillent l'Europe. Sarkozy **sarkoze** et Merkel **merkèlise**.

                                         (Internet)

       'Financial spasms are tormenting Europe. Sarkozy is acting like Sarkozy and Merkel is acting like Merkel.'

   d.   Quand on **pédantise**, on essaie d'accorder les participes correctement.   (Internet)

       'When one acts pedantically, one tries to make participles agree correctly.'

Behavior-related verbs can be derived from common nouns (e.g. French *lézard* 'lizard') or from proper nouns that refer to individuals associated with typical behavioral patterns. They can also be derived from a subset of evaluative adjectives (e.g. French *pédant* 'pedantic'), sometimes called *propensity adjectives* (Oshima 2009). In this paper, we focus on behavior-related unergartive verbs from nouns, of which further examples are given in (3) and (4).[2]

(3)   a.   *aristotéliser* 'develop thoughts like Aristotle'   (From proper nouns)

      b.   *bovaryser* 'behave like Bovary'

      c.   *cicéroniser* 'imitate the language/style of Cicero'

      d.   *merkéliser* 'behave like Merkel; express political views close of those of Merkel'

      e.   *ronsardiser* 'write like Ronsard'

      f.   *stendhaliser* 'write or behave like Stendhal'

(4)   a.   *athéiser* 'to practise/teach atheism' < *athée* 'atheist'   (From common nouns)

      b.   *bateler* 'make acrobatics, buffooneries' < *bateleur* 'acrobat, buffoon'

      c.   *babouiner* 'to monkey around' < *babouin* 'baboon'

      d.   *diplomatiser* 'behave like a diplomat' < *diplomate* 'diplomat'

      e.   *gaminer* 'behave in a youngster way' < *gamin* 'youngster/kid'

      f.   *girouetter* 'act like a weathercock, by changing one's opinions or behavior' < *girouette* 'weathercock'

      g.   *guignoler* 'behave like a Guignol' < *guignol* 'clown' (Guignol is a famous puppet from Lyon)

      h.   *hussarder* 'behave with courage, rapidity' < *hussard* 'hussar'

      i.   *lambiner* 'act with slowness, languidity and nonchalance and lose one's time' < *lambin* 'slowpoke'

      j.   *lézarder* 'stay lazily in the sun' < *lézard* 'lizard'

      k.   *paladiner* 'behave like a paladin' < *paladin* 'wandering knight'

      l.   *putasser* 'behave like a prostitute' < *pute* 'whore'

      m.   *renarder* 'behave like a fox' < *renard* 'fox'

      n.   *robinsonner* 'live alone like Robinson; wander alone' < *robinson* 'person who lives alone into nature'

      o.   *rossarder* 'move like a rossard' < *rossard* 'nasty guy'

      p.   *somnambuler* 'act like a sleepwalker' < *somnambule* 'sleepwalker'

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[2]In addition to their unergative use, a number of behavior-related verbs have formally identical counterparts that are (anti-)causatives, which we set aside in this paper.

What is the semantics of behavior-related unergative verbs? How does the noun contribute to the semantics of the verb? What is the semantic relation between the noun and the derived verb? To try to answer these questions, we first look at the entailment patterns between the noun and the corresponding behavior-related verb (in section 2). We then review the shortcomings of previous analyses of behavior-related verbs and the figurative reading of nouns (in sections 3 and 4) before presenting our own approach to these constructions (in section 5).

2. Entailment patterns

In section 2.1, we look at the entailment pattern from a behavior-related verb to the corresponding noun. We distinguish the generic from the episodic uses of these verbs and nouns, beginning with the former. In section 2.2, we examine the reverse entailment from the noun to the behavior-related verb.

2.1. Does a behavior-related verb entail the corresponding noun?

The absence of an entailment from a behavior-related verb to the corresponding noun is obvious when the noun is a proper noun, but it has also been observed when the noun is a common noun (see Aronoff 1980, Acquaviva 2009):

(5)   He nurses well (but he's not a nurse).

However, in languages like French and German where nouns of profession can be bare or with a determiner, things are a bit less obvious, as the following examples show:[3]

(6)   Juliette est ∅ diplomate.   (Literal only)
      'Juliette is a diplomat by profession.'

(7)   Juliette est une diplomate.
      'Juliette is a diplomat.'

    a.   'Juliette is a diplomat by profession.'   (Literal)
    b.   'Juliette has properties typical of diplomats.'   (Figurative)

The entailment from the behavior-related verb to the noun is blocked if the noun is used as a bare NP, because the sentence is true only if the subject is 'N' by profession (de Swart et al. 2007, von Heusinger and Wespel 2007); see the (a)-sentences in (8) and (9). However, the entailment arguably succeeds if the noun used with an indefinite article on a figurative reading; see the (b)-sentences in (8) and (9).

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[3]In (6), *diplomate* is a noun. There is also an adjective *diplomate*, in which case (6) does not mean that Juliette is a diplomat by profession.

(8)   Marie putasse.   (Generic)
      'Marie behaves like a whore.'

      a.   ↛ Marie est ∅ pute.
           'Marie is a whore by profession.'
      b.   → Marie est une (vraie) pute.   (Figurative)
           'Marie is a (true) whore.'

(9)   Juliette diplomatise.   (Generic)
      'Juliette behaves like a diplomat.'

      a.   ↛ Juliette est ∅ diplomate.
           'Juliette is a diplomat by profession.'
      b.   → Juliette est une (vraie) diplomate.   (Figurative)
           'Juliette is a (true) diplomat.'

That the (b)-sentences are entailed is not a surprise, because on the figurative reading, the use of the noun has been argued to be correct as long as referent of the subject NP "behaves like an 'N' " (von Heusinger and Wespel 2007) or has the typical properties of an 'N' (de Swart et al. 2007), whether or not the referent actually exercises the corresponding profession. This suggests that the noun is (re)interpreted in the same way in both the behavior-related verb and the figurative reading of the indefinite NP.

Note that although the figurative interpretation of nouns is mostly discussed in works devoted to copular sentences, it is in fact also available when the noun together with an indefinite article is used in other kinds of sentences. For instance, (10) does not entail that I met a diplomat by profession but can be used to mean that the person I met has properties typical of diplomats.

(10)   Hier, j'ai rencontré une (vraie) diplomate !   (Figurative)
       'Yesterday, I met a (true) diplomat!'

The entailment pattern is basically the same for behavior-related verbs derived from proper nouns. For instance, (11a) does not entail (11b) but arguably entails (11c).

(11)   a.   Juliette merkèlise.   (Generic)
            'Juliette behaves like Merkel.'
       b.   ↛ Juliette est Merkel.   (Literal)
            'Juliette is Merkel.'
       c.   → Juliette est une (vraie) Merkel.   (Figurative)
            'Juliette is a (true) Merkel.'

Note, however, that not every proper noun can be easily reinterpreted figuratively in an indefinite noun phrase. Proper nouns like *Bovary* and *Merkel* are special; according to Matushansky (2008: p. 609), they acquire the meaning " 'an individual having the typical properties associated with the unique individual that is called [*Bovary/Merkel*]'. In other words, the proper name here seems

to have become common: a new kind is created, whose members share properties other than just having the same name."

When a behavior-related verb is used episodically, which in French is achieved most saliently with the *passé composé*, it ascribes a certain way of behaving to the referent of the subject NP, as seen in (12a) and (13a). A noun on its figurative reading in an indefinite NP is most pragmatically natural when modified by an adjective such as *vrai* 'true', probably because it helps to exclude the literal reading (generally implausible in an episodic use) and thereby to select the figurative one, as seen in (12b) and (13b) (recall also (10)).

(12) a. Hier, Marie a putassé.
          'Yesterday, Marie behaved like a whore.'
      b. Hier, Marie a été une vraie pute.   (Figurative)
          'Yesterday, Marie was [lit. *has been*] a true whore.'

(13) a. Hier, Juliette a diplomatisé.
          'Yesterday, Juliette behaved like a diplomat.'
      b. Hier, Juliette a été une vraie diplomate.   (Figurative)
          'Yesterday, Juliette was [lit. *has been*] a true diplomat.'

Once the figurative reading of the noun is selected, (12a) and (13a) seem to entail (12b) and (13b), respectively.

2.2. Does a noun entail the corresponding behavior-related verb?

Intuitions about the entailment from a noun on its figurative reading to the corresponding behavior-related verb in generic sentence seem less sharp.[4]

(14) a. Juliette est une diplomate.   (Figurative)
          'Juliette has properties typical of a diplomat.'
      b. $\overset{?}{\rightarrow}$ Juliette diplomatise.   (Generic)
          'Juliette behaves like a diplomat.'

(15) a. Marie est une pute.   (Figurative)
          'Marie has properties typical of a whore.'
      b. $\overset{?}{\rightarrow}$ Marie putasse.   (Generic)
          'Marie behaves like a whore.'

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[4]For a bare NP, the entailment from a noun to the corresponding behavior-related verb does not go through because one can be a diplomat by profession without behaving like a diplomat (consider the case of atypical diplomats).

(16) a.   Marie est une (vraie) Bovary.   (Figurative)
          'Marie is a (true) Bovary (has properties typical of Bovary).'
      b. $\overset{?}{\rightarrow}$ Marie bovaryse.   (Generic)
          'Marie behaves like Bovary.'

Two differences between the noun and the corresponding behavior-related verb account for the hesitation to endorse the entailments in (14)–(16).

Firstly, while the property ascribed by the noun on a figurative reading may be stative or eventive, the property ascribed by a behavior-related verb may only be eventive. For example, (14a) may be true if Juliette resembles typical diplomats in that she is well-groomed and has an expensive briefcase. Such stative properties of diplomats do not make (14b) true. In order for (14b) to be true, Juliette has to *behave* like a typical diplomat (e.g. to express herself discreetly).

Secondly, a noun may also be understood as ascribing an intensional property that is never instantiated in an actual event, whereas a behavior-related verb in a generic sentence makes a generalization about the actual behavior of the referent of the subject NP. In other words, the difference between the (a)- and (b)-sentences in (14)–(16) is reminiscent of the difference between a purely dispositional and an habitual reading of generic sentences (see Dahl 1975, Krifka et al. 1995, Menéndez-Benito 2013). An habitual reading is an inductive generalization inferred from actual instances, whereas a purely dispositional reading normally does not entail actual instances. Consider (17) in this respect.

(17) This machine crushes oranges.

      a.   This machine regularly crushes oranges.   (Habitual)
      b.   This machine has the disposition to crush oranges.   (Purely dispositional)

Note that a behavior-related verb in a generic sentence has only an habitual reading:

(18) Juliette diplomatise.

      a.   #'Juliette has the disposition to behave like a diplomat.'   (Purely dispositional)
      b.   'Juliette regularly behaves like a diplomat.'   (Habitual)

In contrast, a noun on its figurative use can in principle have both an habitual and a purely dispositional reading. For instance, if Juliette is a newborn, a fortune-teller could assert (11c) if she believes Juliette to be a Merkel *en puissance* (even if Juliette has obviously not yet had the opportunity to exercise this power). However, the fortune-teller could not truthfully assert (11a) of Juliette in the same situation.

These two differences explain the reluctance to endorse the entailment from (14a)/(15a)/(16a) to (14b)/(15b)/(16b): it succeeds only on a habitual reading of the (a)-sentences and in a context where the property ascribed is eventive.

We summarize our observations as follows. Firstly, on a generic and episodic reading, a behavior-related verb (e.g. *Juliette diplomatise* 'Juliette behaves like a diplomat'; recall (9)) entails the corresponding noun (e.g. *Juliette est une diplomate* 'Juliette has properties typical of diplomats'; recall (9b)) on its figurative reading. This suggests that the noun is reinterpreted in a similar way in both cases. Secondly, in a generic sentence, a behavior-related verb only allows for an habitual reading and ascribes a typical eventive property of 'N' to the referent of the subject NP, whereas the corresponding noun may have either an habitual or a purely dispositional reading, attributing either a typical eventive or a typical stative property of 'N' to the referent of the subject NP.

3. Previous analyses of behavior-related verbs

In English, behavior-related verbs are either derived without a suffix (the "zero-derived denominal verbs" of Aronoff 1980) or with the suffix *-ize/-ify*.[5] Previous analyses of *-ize/-ify* verbs for English (*despotize, hooliganize, Marxize*) have argued that on the relevant reading, which is often called *similative*, the semantics of these verbs involve an unarticulated comparative component (see Plag 1999, Lieber 1998, 2004):

(19)   "act in a way characterized by (an) 'N'; imitate the manner of (an) 'N' "   (Similative)

Plag (1999: 137) posits a single meaning for *-ize*, shown in (20), from which he aims to derive the similative reading. His analysis adopts a Lexical Conceptual Structure approach. Note that the underlined component in (20) is optional and is not active in the intransitive use of these verbs.

(20) $\underline{\text{CAUSE}}$ ([$]_i$, [GO ([$_{\text{Property, Thing}}$ $]_{\text{Theme, Base}}$; [TO[$_{\text{Property, Thing}}$ $]_{\text{Base/Theme}}$])])

Plag proposes that the noun within the verb is interpreted metonymically and refers to the ideas or the manners of 'N'. For instance, in *Marxize*, the proper noun refers to a body of Marx's ideas. Following (20), the verb in its intransitive use is primarily interpreted as 'go to Marx's ideas', that is, to adopt Marx's ideas. The similative reading is "the result of the inference that if one applies the ideas or manners of a certain person, one acts like that person" (pp. 139–140).

Lieber (2004) proposes that the similative reading lies outside the core meaning of *-ize* verbs and corresponds to a sense extension of the core. The general meaning skeleton she attributes to *-ize*, not given here, has the rough paraphrase "[*x* does something to *y*] such that [*x* causes *y* to become *z*/to go to *z*]" (p. 82). In the sense extension corresponding to the similative reading, the second subevent is dropped, which leaves the first subevent ("[*x* does something to *y*]"), corresponding to the standard schema for activity verbs (pp. 86–87). Through a particular pattern of indexing, the base noun is then identified with the highest argument of the affixal skeleton (the subject), leading to an interpretation of (e.g.) *Marxize* as "*x* Marx-does." This, she suggests, corresponds

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[5]In French, *-iser* and *-ifier* are the corresponding suffixes. However, for several verbs, French usage varies between the "zero-derived" and the "*-iser/-ifier* derived" variants, as in *sarkozer/sarkozyser* 'behave like Sarkozy', *cabotiner/cabotiniser* 'ham it up; overact', and *babouiner/babouiniser* 'monkey around'.

to the expected meaning if we assume that "to 'N'-do" means something like "to do as (an) 'N' does," for example, "to do as Marx does" (p. 88).

Both of these approaches have the merit of trying to provide a unified meaning for *-ify/-ize* verbs. But neither of them manages to capture the semantics of these verbs on their unergative uses. Plag's analysis forces one to postulate that these verbs are primarily change-of-location verbs and that the similative reading is derived from this basic use. But this predicts that on the similative reading, unergative verbs with *-ize* exhibit the properties characteristic of change-of-state verbs, which is not supported by the data. Lieber's analysis does not make explicit what "to 'N'-do" should mean, nor does it state where the reinterpretation as "to do as 'N' does" comes from. Furthermore, neither of these two analyses captures the correlation observed above between the meaning shift of the noun in behavior-related verbs and in the figurative reading of indefinite NPs. They also do not account for the fact that the events denoted have to be typical for 'N'. For example, if Trump accidentally drove his car yesterday like Obama did on January 15, 2015, nothing in these analyses would prevent (21) as being an accurate description of what happened.

(21)   Trump obamized yesterday.

However, the intuition is that Trump's driving the way he did yesterday does not suffice to make (21) true, whereas it does suffice to make (e.g.) *Trump drove like Obama yesterday* true. Lieber or Plag might object that only habits of Obama can be taken into account in a definition of a manner (e.g. his habitual way of driving). But (21) would also not seem to be true if Trump outright imitated Obama's driving, because this property would not appear among the typical properties that speakers commonly attribute to Obama.

4. Previous analyses of the figurative reading of nouns

Since the meaning shift of a noun to a figurative reading in the corresponding behavior-related verb is the same as that of the noun in combination with an indefinite article, one could try to apply a previous analysis of the figurative reading of the noun with an indefinite article to the interpretation of the noun in behavior-related verbs. Unfortunately, existing accounts of these nouns do not capture their figurative reading even if the contrast with the competing bare noun is often observed. Take, for instance, de Swart et al. (2007), who provide one of the most developed analyses of such nouns. According to them, *diplomate* 'diplomat' in its bare version (recall (6)) denotes a capacity (of type *e*), which is then type-shifted to a set expression via their operator CAP. In the indefinite variant (e.g. *un/une diplomate* 'a diplomat'; recall (7)), the determiner triggers a coercion from a capacity to a kind (also of type *e*), followed by the type-shifting to a set expression via the application of Carlson's operator REL (which originates from the determiner). As a result, (7) is said to mean that Juliette is in the set of entities that realizes the kind 'diplomat'. However, as von Heusinger and Wespel (2009) observe, this seems to correctly capture only the literal reading of such a sentence.

Le Bruyn (2010: 144) suggests that the figurative reading can, in fact, be seen as a reinterpretation of the noun as a kind (which he assumes to be basically a capacity noun, following de Swart et al.

2007): "[...] we look for inherent properties we associate with [diplomats] and predicate those of the subject." However, Le Bruyn does not show how one could distinguish between the figurative and the literal readings of an indefinite NP in this way. It seems that another operation on the set of properties of the kind would be required in order to distinguish between these two readings.

Von Heusinger and Wespel (2007: sect. 5) also try to account for the figurative reading of an indefinite NP, but they do not provide the details either. Their proposal is that on this reading, an indefinite NP denotes *manifestations* of the kind 'N'. Accordingly, sentences such as (7) assert that the referent of the subject is in the set of manifestations of the kind 'N'. We may reconstruct their proposal as follows (where rel again is Carlson's realization operator):

(22) $[\![\text{a diplomat}]\!] = \lambda x_m[\text{rel}(x_m, \text{diplomat}_k)]$
       (The set of manifestations x_m of the kind 'diplomat')

Their strategy is then to construe manifestations of the kind diplomat_k as individuals that have properties typical of diplomats. Even so, in the absence of a longer story about how manifestations of a kind are distinguished from stages or realizations of a kind, this treatment of manifestations, which is formally parallel to the tretament of stages, makes manifestations of a kind look suspiciously similar to stages of a kind. The change in terminology alone does not guarantee a difference. Arguably, the denotation in (22) simply gives the stages or realizations of the kind 'diplomat', redubbed as "manifestations."[6]

5. A new approach

In this section, we sketch a new approach to behavior-related verbs derived from common nouns, as well as to the figurative reading of indefinite NPs (in section 5.1), and then we extend it to proper nouns (in section 5.2). The primary aim of this approach is to account for the entailment pattern illustrated in (8) and (9), and the lack of this pattern witnessed in (14)–(16).

5.1. Behavior-related verbs derived from common nouns

As various previous authors have suggested, the relevant part of the corresponding noun meaning in a behavior-related verb is the typical – and by "typical" we now mean stereotypical or prototypical – properties associated with the noun meaning, though we will speak of stereotypical properties (i.e. stereotypes) and assume that prototypical properties are among them. The initial idea is to postulate a relation stereotype between nominal properties N and stereotypes S, as in (23), such that S is a stereotype (i.e. a stereotypical property) of N. For example, if N were diplomat, then stereotype(S, diplomat) would state that S is a stereotype of diplomat (i.e. of diplomats), for example, being discreet or carrying a nice briefcase or being well-groomed.

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[6]To be fair, von Heusinger and Wespel do offer informal reflections on how manifestations and stages differ, but the difference in their formal analysis is ultimately due to an index ("m" for manifestations versus "s" for stages).

(23) $\lambda N \lambda S.\text{stereotype}(S,N)$ 'S is a stereotype of N'   (type $\langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle$)

In (23), we assume for simplicity a classical, non-kind treatment of noun meanings as predicates of individuals, but our approach could be recast using kinds if desired. The relation stereotype could also be intensionalized in various ways, for example, it could be made world-dependent and/or context-dependent, but this is not crucial for our present purposes. Note that although stereotype is an undefined relation in our approach, the hope is that this relation is needed independently of our analysis of behavior-related verbs. Even so, there are three principles that apply to stereotype as we conceive of this relation. The first principle says that every stereotype S of a nominal property N is a property of an individual x or a property of a state s or a property of an event e:

(24)   *Principle.* $\forall S(\exists N(\text{stereotype}(S,N)) \rightarrow \exists x(S(x)) \vee \exists s(S(s)) \vee \exists e(S(e)))$

The second principle says that if S is a stereotype of N, then S does not entail N, which is to say that S is not a hyponym of N:

(25)   *Principle.* $\forall S \forall N(\text{stereotype}(S,N) \rightarrow \neg\forall x(S(x) \rightarrow N(x)))$

Finally, the third principle informally states that if S is a stereotype of N, then S is based on the "facts" of individuals that are N. More formally and verbosely, this principle says that if S is a stereotype of N, then there is an x such that N applies to x, and either S applies to x, or there is a relation R such that R is a thematic relation, and either there is a state s such that S applies to s and R holds between s and x, or there is an event e such that S applies to e and R holds between e and x. Another way of saying this is that this principle requires S to be "grounded" in an individual x that N applies to in such a way that either S applies to x or S applies to a state that x participates in or S applies to an event that x participates in.

(26)   *Principle.* $\forall S \forall N(\text{stereotype}(S,N) \rightarrow \exists x(N(x) \wedge$
       $(S(x) \vee (\exists R(\text{thematic}(R) \wedge (\exists s(S(s) \wedge R(s,x)) \vee \exists e(S(e) \wedge R(e,x))))))))$

In view of this third principle, it will be useful to define a relation exhibit between individuals x and properties S and N ("x exhibits S with respect to N") such that S is a stereotype of N, and either S applies to x, or there is a relation R such that R is a thematic relation, and either there is a state s such that S applies to s and R holds between s and x, or there is an event e such that S applies to e and R holds between e and x:

(27)   *Definition.* $\text{exhibit}(x,S,N)$ ("x exhibits S with respect to N") $:=$
       $\text{stereotype}(S,N) \wedge$
       $(S(x) \vee (\exists R(\text{thematic}(R) \wedge (\exists s(S(s) \wedge R(s,x)) \vee \exists e(S(e) \wedge R(e,x))))))$

After this preface on the relation stereotype, let's turn to the question of how behavior-related verbs are derived, using *diplomatiser* 'behave like a diplomat' as an example. The noun *diplomate* 'diplomat' is straightforwardly analyzed as the following predicate of individuals:

(28)   diplomate ('diplomat') $\rightsquigarrow \lambda x.\mathsf{diplomat}(x)$

Applying the relation $\mathsf{stereotype}$ in (23) to this predicate, we derive the set of stereotypes S of diplomats:

(29) $[\lambda N \lambda S.\mathsf{stereotype}(S,N)](\lambda x.\mathsf{diplomat}(x)) =$ (application)
       $\lambda S.\mathsf{stereotype}(S, \lambda x.\mathsf{diplomat}(x))$
       'The set of stereotypes S of diplomats'

In (29), the stereotypes S of diplomats may be properties of individuals, states, or events (recall (24)), but since behavior-related verbs from nouns are eventive (indeed, also agentive), a treatment of the verbalizing suffix *-iser* should be restricted to those stereotypes S that are *eventive*. Furthermore, instead of imagining that the meaning of *-iser* applies to a predicate of stereotypes such as the one in (29), it seems more natural in light of the data to think of *-iser* as itself introducing stereotypes, for otherwise it would not be clear what element introduces them into the derivation.[7] Finally, we need to posit a notion of *behaving*, which is captured by an event predicate behave. These considerations motivate the following analysis of *-iser*, which is officially "*-iser$_n$*" because it is intended for nominal predicates corresponding to common nouns:

(30)   -iser$_n$ ('behave like') $\rightsquigarrow \lambda N \lambda x \lambda e.\mathsf{agent}(e,x) \wedge \mathsf{behave}(e) \wedge \exists S(\mathsf{stereotype}(S,N) \wedge S(e))$

The predicate in (30) applies to a nominal predicate N, an individual x, and an event e, and yields the conditions that x is the agent of e, e is an event of behaving, and there is a property S such that S is a stereotype of N and S holds of e.

Applying this relation to the nominal predicate in (28), we obtain the following analysis of *diplomatiser$_n$*:

(31)   diplomat-iser$_n$ ('behave like a diplomat') $\rightsquigarrow$
       $[\lambda N \lambda x \lambda e.\mathsf{agent}(e,x) \wedge \mathsf{behave}(e) \wedge \exists S(\mathsf{stereotype}(S,N) \wedge$
       $S(e))](\lambda x'.\mathsf{diplomat}(x')) =$ (application)
       $\lambda x \lambda e.\mathsf{agent}(e,x) \wedge \mathsf{behave}(e) \wedge \exists S(\mathsf{stereotype}(S, \lambda x'.\mathsf{diplomat}(x')) \wedge S(e))$

Applied to an individual x and an event e, this relation yields the conditions that x is the agent of e, e is an event of behaving, and there is a property S such that S is a stereotype of diplomats and S holds of e.

Applying the relation in (31) to the individual constant $\mathsf{juliette}$ (for *Juliette*), we derive the predicate of events e such that Juliette is the agent of e, e is an event of behaving, and there is a property S such that S is a stereotype of diplomats and S holds of e:

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[7]We assume a null suffix in the case of "zero-derived" behavior-related verbs (recall (5) and fn. 5), but another strategy would be imaginable (e.g. a redundancy rule).

(32)   Juliette diplomatiser$_n$ ('Juliette behave like a diplomat') $\rightsquigarrow$ (via application)
     $\lambda e.\mathsf{agent}(e, \mathsf{juliette}) \wedge \mathsf{behave}(e) \wedge \exists S(\mathsf{stereotype}(S, \lambda x'.\mathsf{diplomat}(x')) \wedge S(e))$

The idea that the meaning of a behavior-related verb contains the component behave is motivated by the contrast between the answers in (33a) and (33b) to the question in (33).

(33)   Comment est-ce que Juliette s'est comportée ?
     'How did Juliette behave?'

     a.   Elle a diplomatisé.
         'She behaved like a diplomat.'
     b.   #Elle a mangé une pomme.
         'She ate an apple.'

Turning to the use of a noun on its figurative reading in an indefinite NP (recall e.g. (7)), we can again employ the relation $\mathsf{stereotype}$ to treat this reading. However, in this case, it is arguably the meaning of the indefinite article *un/une* 'a(n)' that introduces stereotypes. There are *two* readily available ways of analyzing *un/une* 'a(n)' as introducing stereotypes.
The *first* is give *un/une* 'a(n)' a non-quantificational (predicative) analysis: the meaning of the indefinite article[8] applies to a nominal property N and yields a predicate of individuals x such that there exists a stereotype S that x exhibits with respect to N (recall (27)), as in (34).

(34)   un/une$_{fnq}$ ('a(n)') $\rightsquigarrow \lambda N \lambda x.\exists S(\mathsf{exhibit}(x, S, N))$

Applied to the predicate $\mathsf{diplomat}$, this meaning of the indefinite article yields the following predicate, which denotes the set of individuals x such that there is a stereotype S that x exhibits with respect to diplomats:

(35)   un/une$_{fnq}$ diplomate ('a diplomat') $\rightsquigarrow$
     $[\lambda N \lambda x.\exists S(\mathsf{exhibit}(x, S, N))](\lambda x'.\mathsf{diplomat}(x')) =$ (application)
     $\lambda x.\exists S(\mathsf{exhibit}(x, S, \lambda x'.\mathsf{diplomat}(x')))$

The following simple-minded analysis of the copula *est* 'is' (ignoring tense) takes the copula to apply to a predicate P of individuals in order to yield a relation between states s and individuals x such that P applies to x and x is the theme of s:

(36)   est ('is') $\rightsquigarrow \lambda P \lambda x \lambda s.P(x) \wedge \mathsf{theme}(s, x)$

Observe that the states s denoted by this analysis of *est* 'is' are "light" in that they barely have any descriptive content: the only condition is that the individuals x are their themes. This "lightness" suggests the following innocent principle, which says that if an individual x stands in a thematic relation R to an event e, then there is a state s such that x is the theme of s:

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[8]Which is designated by *un/une$_{fnq}$*, where the subscript "fnq" stands for "figurative non-quantificational."

(37)   *Principle.* $\forall x (\exists R \exists e (\mathsf{thematic}(R) \wedge R(e,x)) \to \exists s (\mathsf{theme}(s,x)))$

In other words, if an individual x participates (thematically) in an event e, then there is a state s that x is the theme of. This principle will be useful below.

Applying the analysis of *est* 'is' in (36) to the predicate in (35), we derive the relation between states s and individuals x such that there is a stereotype S that x exhibits with respect to diplomats and x is the theme of s:

(38)   est un/une$_{fnq}$ diplomate ('is a diplomat') $\rightsquigarrow$ (via application)
         $\lambda x \lambda s. \exists S (\mathsf{exhibit}(x, S, \lambda x'.\mathsf{diplomat}(x'))) \wedge \mathsf{theme}(s,x)$

If this relation is applied to the individual constant juliette, we obtain the predicate of states s such that there is a stereotype S that Juliette exhibits with respect to diplomats and Juliette is the theme of s:

(39)   Juliette est une$_{fnq}$ diplomate ('Juliette is a diplomat') $\rightsquigarrow$ (via application)
         $\lambda s. \exists S (\mathsf{exhibit}(\mathsf{juliette}, S, \lambda x'.\mathsf{diplomat}(x'))) \wedge \mathsf{theme}(s,\mathsf{juliette})$

We will briefly mention the *second* readily available way of analyzing *un/une* 'a(n)' as introducing stereotypes, which is a quantificational analysis (hence *un/une$_{fq}$*):

(40)   un/une$_{fq}$ ('a(n)') $\rightsquigarrow \lambda N \lambda R \lambda v. \exists x (\exists S (\mathsf{exhibit}(x, S, N)) \wedge R(v,x))$

In (40), R is a relation (corresponding to the VP meaning) between eventualities (events or states) v and individuals x. Applied to the predicate diplomat, the following quantifier is derived, which if applied to a relation R between eventualities and individuals, yields a predicate of eventualities v such that there is an individual x and a stereotype S such that x exhibits S with respect to diplomats and R holds between v and x:

(41)   un/une$_{fq}$ diplomate ('a diplomat') $\rightsquigarrow$ (via application)
         $\lambda R \lambda v. \exists x (\exists S (\mathsf{exhibit}(x, S, \lambda x'.\mathsf{diplomat}(x'))) \wedge R(v,x))$

This use of *un/une$_{fq}$ diplomate* 'a diplomat', which is figurative and quantificational, figures in sentences such as (10).

We conclude this section with the remark that the analyses presented above allow us to account for why the sentence in (9) with *diplomatiser$_n$* 'behave like a diplomat' (see (32)) entails the sentence in (9b) with *une$_{fnq}$ diplomate* 'a diplomat' (see (38)), ignoring tense. This entailment is due to the following fact:

(42) *Fact.* $\forall e(\mathsf{agent}(e, \mathsf{juliette}) \land \mathsf{behave}(e) \land \exists S(\mathsf{stereotype}(S, \lambda x'.\mathsf{diplomat}(x')) \land S(e)) \rightarrow$
$\exists s(\exists S(\mathsf{exhibit}(\mathsf{juliette}, S, \lambda x'.\mathsf{diplomat}(x'))) \land \mathsf{theme}(s, \mathsf{juliette}))$

The proof of this fact is straightforward and uses the definition in (27) and the principle in (37). Intuitively, this entailment is valid because a stereotype that makes (9) true is necessarily eventive, but then it counts as a stereotype that also makes (9b) true.

We can also show that the reverse entailment is not valid (recall also (14)), because a stereotype that makes (9b) true need not be eventive, whereas a stereotype that makes (9) true is necessarily eventive.

5.2. Behavior-related verbs derived from proper nouns

Unsurprisingly, we adopt the same basic approach to behavior-related verbs from proper nouns, but with the difference that the stereotypes are now of individuals as opposed to nominal properties (sets of individuals). Note, however, that the relation stereotype as given in (23) is not applicable to individuals directly, and so we need to define a derived relation, designated by $\mathsf{stereotype'}$, between stereotypes S and individuals x, which effectively treats x as a singleton (the set of individuals identical to x), as shown in (43).

(43) *Definition.* $\lambda x \lambda S.\mathsf{stereotype'}(S, x)$ ("S is a stereotype of x") :=
$\lambda x.[[\lambda N \lambda S.\mathsf{stereotype}(S, N)](\lambda x'.x' = x)] = \text{(application)}$
$\lambda x \lambda S.\mathsf{stereotype}(S, \lambda x'.x' = x)$

As an illustration, let's consider the proper noun *Merkel* and its standard treatment as an individual constant, here merkel:

(44) Merkel $\rightsquigarrow$ merkel

Applying the relation $\mathsf{stereotype'}$ to this constant, we obtain the set of stereotypes of Merkel:

(45) $\lambda S.\mathsf{stereotype'}(S, \mathsf{merkel})$
'The set of stereotypes S of Merkel'

In order to derive the behavior-related verb *merkéliser* 'behave like Merkel', we need a version of *-iser* (cf. *-iser$_n$* in (30)) that is applicable to individuals instead of nominal properties. This version, *-iser$_{pn}$* ("pn" for "proper noun"), is analogous to *-iser$_n$* but makes use of $\mathsf{stereotype'}$ in place of stereotype:

(46) *-iser$_{pn}$* ('behave like') $\rightsquigarrow \lambda y \lambda x \lambda e.\mathsf{agent}(e, x) \land \mathsf{behave}(e) \land \exists S(\mathsf{stereotype'}(S, y) \land S(e))$

The behavior-related verb *merkéliser* 'behave like Merkel' is then derived via the application of *-iser$_{pn}$* to *Merkel*:

(47)   merkél-iser$_{pn}$ ('behave like Merkel') $\rightsquigarrow$ (via application)
       $\lambda x \lambda e.\text{agent}(e,x) \wedge \text{behave}(e) \wedge \exists S(\text{stereotype}'(S,\text{merkel}) \wedge S(e))$

As seen in (47), the result is a relation between events e and individuals x such that x is the agent of e, e is an event of behaving, and there is an S such that S is a stereotype of Merkel and S applies to e.

Applied to the individual constant juliette, the relation in (47) yields (ignoring tense) the predicate of events e such that Juliette is the agent of e, e is an event of behaving, and there is an S such that S is a stereotype of Merkel and S applies to e:

(48)   Juliette merkél-iser$_{pn}$ ('Juliette behave like Merkel') $\rightsquigarrow$ (via application)
       $\lambda e.\text{agent}(e,\text{juliette}) \wedge \text{behave}(e) \wedge \exists S(\text{stereotype}'(S,\text{merkel}) \wedge S(e))$

The present approach can be naturally extended to treat examples where a proper noun appears with an indefinite article:

(49)   a.   Juliette est une (vraie) Merkel.
            'Juliette is a (true) Merkel.'
       b.   Juliette est une autre Merkel.
            'Juliette is another Merkel.'

To treat the figurative use of the indefinite NP in (49), it is first convenient to define a derived relation exhibit$'$ that is based on the relation stereotype$'$, analogous to the relation exhibit from (27) (which is based on stereotype):

(50)   *Definition.* $\text{exhibit}'(x,S,y)$ ("x exhibits S with respect to y") $:=$
       $\text{stereotype}'(S,y) \wedge$
       $(S(x) \vee (\exists R(\text{thematic}(R) \wedge (\exists s(S(s) \wedge R(s,x)) \vee \exists e(S(e) \wedge R(e,x))))))$

The next step is to propose an analogue of *un/une$_{fnq}$* from (34) that makes use of the relation exhibit$'$, applying to individuals:

(51)   un/une$_{fnq'}$ ('a(n)') $\rightsquigarrow \lambda y \lambda x.\exists S(\text{exhibit}'(x,S,y))$

Applied to merkel, this relation yields the predicate of individuals x such that there is a stereotype S that x exhibits with respect to Merkel:

(52)   une$_{fnq'}$ Merkel ('a Merkel') $\rightsquigarrow$ (via application)
       $\lambda x.\exists S(\text{exhibit}'(x,S,\text{merkel}))$

If the meaning of *est* 'is' given in (36) is then applied to this predicate, the following relation between states and individuals is derived (cf. (38)):

(53)   est une$_{fnq'}$ Merkel ('is a Merkel') $\rightsquigarrow$ (via application)
       $\lambda x \lambda s.\exists S(\mathsf{exhibit}'(x, S, \mathsf{merkel})) \wedge \mathsf{theme}(s, x)$

Finally, if we apply this relation to the individual constant juliette, we obtain the predicate of states *s* such that there is a stereotype *S* that Juliette exhibits with respect to Merkel and Juliette is the theme of *s*, which is arguably a reasonable rendering of *une (vraie/autre) Merkel* 'a (true)/another Merkel' in (49) (neglecting the adjective):

(54)   Juliette est une$_{fnq'}$ (vraie) Merkel ('Juliette is a (true) Merkel') $\rightsquigarrow$ (via application)
       $\lambda s.\exists S(\mathsf{exhibit}'(\mathsf{juliette}, S, \mathsf{merkel})) \wedge \mathsf{theme}(s, \mathsf{juliette})$

We point out that on this approach, *Juliette merkèlise$_{pn}$* 'Juliette behaves like Merkel' entails the sentence in (49), but not vice versa, for the same reasons as before (cf. (42)):

(55)   *Fact.* $\forall e(\mathsf{agent}(e, \mathsf{juliette}) \wedge \mathsf{behave}(e) \wedge \exists S(\mathsf{stereotype}'(S, \mathsf{merkel}) \wedge S(e)) \rightarrow$
       $\exists s(\exists S(\mathsf{exhibit}'(\mathsf{juliette}, S, \mathsf{merkel})) \wedge \mathsf{theme}(s, \mathsf{juliette}))$

In closing, a fact described in section 2.2 is still in need of an explanation. Recall that the generic reading of a noun used figuratively may be habitual or purely dispositional, whereas the generic reading of a behavior-related verb may only be habitual. Why is the purely dispositional reading blocked for behavior-related verbs? Although we cannot provide a detailed answer to this question, we believe that the element responsible for this phenomenon is the predicate behave that is part of the denotation of behaviour-related verbs, but not of the nouns from which they derive. To say of a referent that she *behaves* in a stereotypical way seems to only make sense if the referent has actually exhibited this behavior before, whereas to say of a referent that she has a stereotypical property allows for the possibility that this property is purely dispositional.

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The likelihood of upper-bound construals among numeral modifiers[1]

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Abstract.

In this paper we show that modified numerals differ with respect to the nature of the bounds they express. We examine the numeral modifiers *less/fewer than*, *at most* and *up to* in a series of experiments in English and Greek, and investigate to what extent these modifiers impose an upper bound. Our results indicate that the upper-bound construal that *up to* gives rise to is cancellable in contrast with the uncancellability of the upper-bound construal that *at most* and *less/fewer than* give rise to. This finding is compatible with an analysis that treats the upper bound of *at most* and *less/fewer than* as part of their semantic content and the upper bound of *up to* as a pragmatic inference. In addition, we discuss the effect of the scalar distance between possible alternatives and the modified numeral on the likelihood and strength of the upper-bound construal.

Keywords: Numeral modifiers, scalar implicature, experimental semantics and pragmatics.

1. Introduction

Numeral modifiers provide a fruitful case study of several theoretically-relevant semantic and pragmatic phenomena, specifically ignorance inferences, free choice inferences, scalar implicatures, and interaction with granularity (Geurts and Nouwen, 2007; Büring, 2008; Cummins and Katsos, 2010; Nouwen, 2010; Schwarz, 2011; Cummins et al., 2012; Schwarz, 2013; Kennedy, 2013, 2015; Cohen and Krifka, 2014)

The focus of our experimental investigation is the diversity of scalar inferences, particularly upper-bound construals, among different modified numerals. Blok (2015) claims that modified numerals differ in how their upper-bound inferences are derived: the upper bound of *at most* and *less/fewer than* is part of the semantic content whereas the upper bound of *up to* is derived pragmatically. In order to test these intuitions, we developed a task that utilizes a modified Likert scale in order to obtain gradient judgements on the strength of the upper bound construal, on the assumption that consistent responses to an upper-bound reading point to it being semantic, while varied or gradient

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responses point to it being pragmatic.

In Section 2, we motivate the experimental investigation of the three numeral modifiers. We begin in Section 2.1 with the initial observation in Geurts and Nouwen (2007) that numeral modifiers divide into two classes based on whether they give rise to ignorance inferences: *up to* and *at most* belong to the same class as they both give rise to ignorance inferences, while *less/fewer than* belongs to a different class, as it doesn't. Despite this class distinction, however, modifiers from neither class give rise to scalar implicature, in contrast with bare numerals, as discussed in Section 2.2, unless granularity comes into play, as discussed in Section 2.3. But if the upper bound of bare, but not modified, numerals, is derived via scalar implicature, how is it derived in the modified numeral *up to* when granularity isn't at stake? A look at the monotonicity of the modifiers reveals that *at most* and *less/fewer than* are downward-monotone, while *up to* isn't, suggesting that the upper bound of the first two is entailed while the upper bound of the latter is derived via a pragmatic inference (Section 2.4). On the assumption that pragmatic inferences are cancellable and lead to variable responses, as discussed in Section 2.5, we test the nature of the upper bound in the three numeral modifiers in Greek (Section 3) and English (Section 4). In Section 5, we discuss additional factors that may contribute to the degree of upper-bound cancellability.

2. Inferences numeral modifiers give rise to

2.1. Ignorance inferences

Geurts and Nouwen (2007) show that superlative modifiers like *at most* give rise to ignorance inferences. Nouwen (2010) argues that the absence or occurrence of such inferences is the hallmark of an essential distinction between two classes of scalar quantifiers. CLASS A numeral modifiers like *more than, less/fewer than, under* and *over* don't give rise to ignorance inferences. This is why explicitly expressing knowledge of an exact number, e.g., how much memory the speaker's laptop has in (1a), can be followed by a numeral modified by this class of modifiers. In contrast, CLASS B modifiers like *at least, at most, minimally, maximally* and *up to* do lead to ignorance inferences, and so following up an utterance with explicitly-communicated speaker certainty with a numeral modifier of this class is infelicitous, as in (1b).

(1)   a.   **Class A**

I know exactly how much memory my laptop has, and it's $\left\{ \begin{array}{l} \text{more than} \\ \text{less than} \\ \text{under} \\ \text{over} \end{array} \right\}$ 4GB.

       b.   **Class B**

$$\text{\#I know exactly how much memory my laptop has, and it's} \left\{ \begin{array}{l} \text{at least} \\ \text{at most} \\ \text{minimally} \\ \text{maximally} \\ \text{up to} \end{array} \right\} \text{4GB.}$$

As will be shown in the following sections, while ignorance inferences constitute a point of variation among numeral modifiers, all of these expressions behave similarly with respect to scalar implicature. Specifically, none of them give rise to scalar implicatures when they are not embedded under certain operators or when fine granularity is involved.

2.2. Scalar implicature

The classic analysis of number words is that they have a one-sided, lower-bound only meaning, and that the exact, upper- as well as lower-bound meaning is derived by scalar implicature. The listener reasons that by asserting *three* in (2), the speaker doesn't know if greater numbers, e.g., four, hold. Strengthening this implicature, such that the speaker knows that greater numbers don't hold, leads to the implicature in (2), following '⤳,' which stands for 'is used to implicate' (Horn, 1972; Gazdar, 1979; Levinson, 2000; Sauerland, 2004; Geurts, 2010).[2]

(2)   John has three children.
       ⤳ John doesn't have four children.

Krifka (1999) and Fox and Hackl (2006) observe that when the number word combines with a numeral modifier like *more than*, the upper-bound inference doesn't hold, as illustrated by (3a), where '⤳̸' stands for 'doesn't implicate'. Additional downward-entailing numeral modifiers like *at most* and *fewer than* don't give rise to scalar implicature, either, as shown in (3b) and (3c) below.

(3)   a.   John has more than three children.
             ⤳̸ John doesn't have more than four children.
       b.   At most ten people died in the crash.
             ⤳̸ It's not the case that at most nine people died in the crash.
       c.   Fewer than ten people died in the crash.
             ⤳̸ Fewer than nine people died in the crash.

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[2]That said, amassing evidence and arguments suggest a two-sided analysis of numbers (Horn, 1992; Musolino, 2004; Geurts, 2006; Huang et al., 2013; Kennedy, 2013).

The prevailing family of accounts for the lack of scalar implicature says that sentences with modified numerals are evaluated against alternatives with other modified numerals substituted for the modified numeral in the sentence, e.g., *fewer than* and *exactly*, would be substituted for *at most*.[3] The alternatives for sentences like (2) or (3) are symmetric; that is, they can't be simultaneously false while the assertions in (2) or (3) are true, and so the implicatures don't arise.

However, comparative and superlative modifiers give rise to scalar implicatures in the scope of certain operators, such as certain modals, universal nominal quantifiers, distributive conjunctions, and the quantifier *more than half of the NPs* (Mayr, 2013). Similarly, as will be discussed in the following section, both comparative and superlative modifiers trigger scalar implicatures when granularity is taken into consideration.

2.3. Granularity and scalar distance

Cummins et al. (2012) observe that under certain circumstances, some upper-bound inferences are available from utterances with comparative and superlative modifiers. For example, if Ahmed were born in Cairo, the statement in (4) would be semantically true but intuitively misleading, as *more than 1000* and *at least a 1000* seem to convey a quantity that is less than the actual population of Cairo (about 10 million).

(4)   Ahmed's birthplace has $\left\{ \begin{array}{c} \text{more than} \\ \text{at least a} \end{array} \right\}$ 1000 inhabitants.

Cummins et al. (2012) find that the range of numbers communicated by utterances with modified numerals depends on the granularity of the numeral. When a speaker uses a non-round, precise number like 93, she signals to the speaker that this number should be interpreted as 'exactly 93.' That is, a number like 93 has a fine-granularity interpretation. When a speaker, however, uses a round number like 110, it's likely interpreted as a range of values that includes 110; that is, it receives a medium-granularity interpretation. And finally, when a speaker uses a round number like 100, the number is likely interpreted as a greater range of potentially-communicated values than 110, thus receiving a coarse-granularity interpretation (Krifka, 2007). This strategic communication of the approximate interpretation of numbers indeed affects the interpretation of modified numerals. In an experimental investigation, Cummins et al. found that the interpreted upper bound for *more than 100*, which represents coarse granularity, was 149, the upper bound for *more than*

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[3]The various accounts differ in the details of how alternatives are computed, but the resulting inferences are the same. Schwarz (2011, 2013) assumes the Horn set {*at least, exactly, at most*} of scalar modifiers in addition to the Horn set of numerals. Mayr (2013) assumes the Horn sets {*at least, at most*} and {*less/fewer than, more than*} for the relevant numeral modifier and the numeral scale. Kennedy (2013) proposes that in the alternatives the numeral is kept constant while *at least n* is substituted by *more than n* (and *at most n* is substituted by *less than n*) and the bare numeral, for which he assumes a two-sided semantics.

110, which represents medium granularity, was 127.5, and the interpreted upper bound for *more than 93*, which represents fine granularity, was 100. Results for the superlative modifier *at least* revealed similar patterns.

In the last two sections, we saw that certain Class A and Class B numeral modifiers behave similarly with respect to scalar implicatures. In the following section we'll focus on Class B numeral modifiers and examine the differences among them with respect to monotonicity and bounds.

2.4. Monotonicity and boundedness

Schwarz et al. (2012) observe that negative polarity items are licensed in the scope of *at most*, but not in the scope of *up to*, concluding that the former, but not that latter, should be analyzed as downward monotone. Based on this and other observations, they conclude that there must be a fundamental semantic difference between these two modifiers. Building on this observation, Blok (2015) argues that this crucial difference is (in part at least) due to the fact that the upper bound expressed by *up to* is implicated rather than entailed. This accounts for the fact that the upper bound set by *at most 23 people* in (5a) cannot be cancelled, whereas the upper bound set by *up to 23 people* in (5b) is cancellable.

(5)   a.   At most 23 people came to the party, # if not 24.
         b.   Up to 23 people came to the party, if not 24.

Blok further proposes that while *at most n* denies the existence of occurrences of values higher than *n*, *up to n* asserts the existence of values between some implicit lower bound and *n*. Higher values are only excluded by implicature. Based on a survey of 15 different languages, Blok concludes that the contrast between the counterparts of *at most* and *up to* is a crosslinguistically-consistent contrast.

2.5. Degree of cancellability and strength of implicature

Generalized conversational implicatures and specifically scalar implicatures have been treated as a categorical phenomenon. This assumption dates back to (Grice, 1975), who says that "the use of a certain form of words in an utterance would normally (in the ABSENCE of special circumstances) carry such-and-such an implicature or type of implicature." There is, however, evidence from the processing literature that scalar implicatures are not computed by default (Breheny et al., 2006). Similarly, in Bott and Noveck (2004), a pragmatically-enriched interpretation (i.e., 'some but not all') of the sentence in (6) would contradict the fact that all elephants are mammals, but a logical

interpretation (i.e., 'some and possibly all') would not. However, even participants who were trained to interpret *some* as 'some but not all' accepted the sentence in (6) in 60% of the cases, in contrast with a 85% acceptance rate in the logical condition.

(6)   Some elephants are mammals.

What these results show is that the presence of an implicature leads to a certain level of variability in responses. In what follows, we will use this characteristic to test the nature of the upper bound expressed by *up to*. If the upper bound interpretation of *up to* is derived via scalar implicature, then we expect a variable response pattern for (7a) given (8), suggesting that (7a) and (8) can be compatible just in case the upper bound implicature is cancelled. We expect (7b) and (7c), in contrast, to be always incompatible with (8), as the upper bound is part of the semantic content and therefore can't be cancelled (see Blok, 2015 for *at most* and Fox and Hackl, 2006; Nouwen, 2010 for *less/fewer than*).

(7)   a.   Interns in advertisement companies get **up to** 980 dollars per month.
        b.   Interns in advertisement companies get **less than** 980 dollars per month.
        c.   Interns in advertisement companies get **at most** 980 dollars per month.

(8)   The interns in some of them are paid **985** dollars per month.

3. Experiment 1: Greek

3.1. Research questions

In Experiment 1, we set to answer two research questions: (i) is the upper bound of *up to* cancellable, in support of an implicature-based account; and (ii) if so, to what extent? In order to investigate the degree of upper-bound cancellability of *up to*, we compare it with *at most* and *less/fewer than*, on the assumption that the upper-bound inference in the latter two is part of the semantic content and is therefore consistent.

3.2. Methods

Experiment 1 was conducted in Greek. The Greek directional numeral modifier equivalent to *up to* is the preposition *mehri*. *To poli* (lit. 'the much') is the Greek counterpart of *at most*, and the adjective *lighoteros/-i/-o apo* (lit. 'fewer.MASC/FEM/NEUT than') and the adverb *lighotero apo* correspond to *fewer than* and *less than*, respectively.

In the experimental task, we asked participants to rate how coherent sentence continuations like the one in (9) were on a modified Likert scale of –3 to 3, where –3 was a "very bad" continuation and 3 was a "very good" continuation. After the instructions and before the actual questionnaire, participants were presented with two practice items, one coherent discourse and one contradictory discourse, which had the form of the filler items (see (10) and (11) below). This served to familiarize participants with the procedure. The first sentence in each pair of sentences was adapted from naturally-occurring tokens gleaned from the Hellenic National Corpus (`http://hnc.ilsp.gr/en/default.asp`).

In the target items, the first sentence was always a general claim, while the second sentence was a more specific claim, highlighting one of the cases the first, general claim was referring to. The first sentence included a number n modified by a numeral modifier; n was almost exclusively a non-round number. The second sentence had a number m, which was either slightly smaller than n in the first sentence ($m < n$; the 'under' condition) or slightly greater than n ($m > n$; the 'over' condition).

(9)   Example target item:

I askumeni stis dhyafimistikes eteries pernun $\left\{\begin{array}{c}\text{lighotero apo}\\\text{to poli}\\\text{mehri}\end{array}\right\}$ n dholaria ton mina; <u>i</u> <u>askumeni se arketes apo aftes plirononde m dholaria ton mina.</u>

'Interns in advertisement companies get $\left\{\begin{array}{c}\text{less than}\\\text{at most}\\\text{up to}\end{array}\right\}$ n dollars per month; <u>the interns</u> <u>in some of them are paid m dollars per month.</u>'

Is the underlined sentence a good continuation of the first sentence?

	–3	–2	–1	0	1	2	3	
	very bad						very good	

Thus, in our 3×2 design, conditions differed with respect to the choice of modifier (*lighotero/lighoteros/-i/-o apo* 'less/fewer than', *to poli* 'at most', *mehri* 'up to') in the first sentence and with respect to whether the number in the underlined continuation was smaller or greater than the number in the first sentence (discrepancy factor: 'under' and 'over' levels). The comparative numeral modifier and 'under' were the reference levels of these two factors, respectively.

All target items (N=12) were rotated through six lists in a latin square design, so that each participant only saw one condition per item. Fourteen filler items including seven coherent discourses and seven contradictory discourses were added into the mix, too (see translated example items below), making a total of 26 stimuli.

(10)   Example of coherent filler item:
         Several countries have more than one official language; for example, Belgium has three
         official languages: Dutch, French and German.

(11)   Example of contradictory filler item:
         The Panhellenic examinations started at the end of May; specifically, the examination of
         the first subject took place on the 10th of June.

218 participants filled in an online questionnaire created on www.surveymonkey.com. Data from
67 participants were discarded, because they did not fill in the entire questionnaire or they were
not native speakers of Greek. Eight additional participants were excluded, as they gave scores
greater than –1 to the contradictory fillers and smaller than 1 to the coherent fillers. Data from the
remaining 143 participants (98 female participants, 2 didn't specify gender; mean age: 32.8; age
range: 19–67) were used for the statistical analyses reported on here.

3.3. Predictions

Schwarz et al. (2012) argue that the upper bound of both *at most* and *up to* is entailed and would
therefore predict no difference in the degree of upper-bound construals between these two numeral
modifiers. Blok (2015), on the other hand, argues that *at most*, but not *up to*, entails an upper bound
and thus predicts a difference in the degree of upper-bound inferences between the two numeral
modifiers. If we find that participants are more likely to approve of an 'over' item when the
modifier is *mehri* 'up to' than when it is *to poli* 'at most', this will support Blok's (2015) analysis.
On the assumption that *less/fewer than* imposes a semantic upper bound as well (Hackl, 2000;
Nouwen, 2010), we would expect participants to make the same distinction between *lighotero apo*
'less than' and *mehri* 'up to'. In the 'under' condition, since the values in the continuation are
entailed by the first sentence with the modified numeral, we would expect no difference among the
modified numeral conditions.

3.4. Results

The data obtained by 143 participants, summarized in Figure 1, were analyzed with mixed-effects
ordered probit regression models using the ordinal R package (Christensen, 2013). The full model
with modifier, discrepancy, and their interaction as fixed effects, with random intercepts and slopes
for modifier, discrepancy, and their interaction for subjects, and with random intercepts and slopes
for items was found to be the best fit for our data ($LRstatistic = 22.68$, $df = 4$, $p < .001$). This
model showed a marginally significant difference between the modifiers *lighotero apo* 'less than'
and *mehri* 'up to' ($\beta = -.244$, $SE = .127$, $p = .055$), a significant difference between the 'under'

and 'over' conditions ($\beta = -1.532$, $SE = .171$, $p < .0001$), and a significant interaction for *mehri* 'up to' and 'over' ($\beta = .472$, $SE = .139$, $p < .001$).

We investigated the modifier effect for each of the two discrepancy conditions with two additional models. Both models had modifier as the only fixed effect. The analysis for the 'over' condition revealed that items with *mehri* 'up to' received significantly higher coherence rates than items with *lighotero apo* 'less than' ($\beta = .226$, $SE = .092$, $p < .05$) or *to poli* 'at most' ($\beta = .306$, $SE = .093$, $p < .001$). No difference was found between *lighotero apo* 'less than' and *to poli* 'at most' ($\beta = -.08$, $SE = .093$, $p <= .389$). In the analysis for the 'under' condition, items with *mehri* 'up to' were found to be borderline significantly different from *lighotero apo* 'less than', with the former scoring lower ($\beta = -.245$, $SE = .146$, $p = .093$), and significantly lower than the *to poli* 'at most' items ($\beta = -.291$, $SE = .111$, $p < .01$). Again, there was no difference in the scores for *lighotero apo* 'less than' and *to poli* 'at most' ($\beta = .046$, $SE = .157$, $p = .769$).
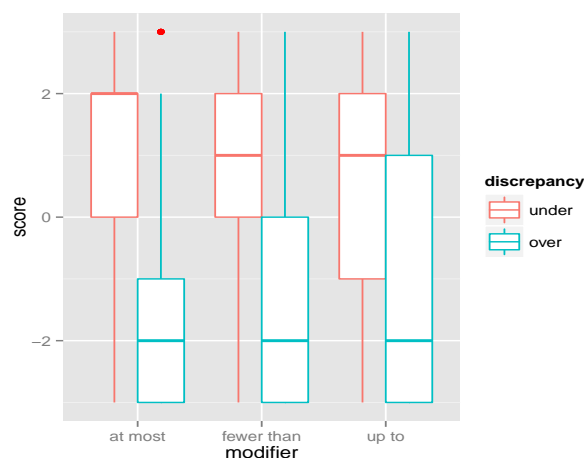
Figure 1: Coherence scores per numeral modifier in the 'under' and 'over' conditions

3.5. Discussion

We assume that what guided participants in rating the coherence of the sentence continuations they read is whether the information in the second and more specific underlined sentence was compatible with the information in the first and more general sentence. Since we manipulated the numbers in the second sentence only, we expect participants to identify the numbers as the crucial point of comparison between the two sentences. The explicit use of anaphora in the second, underlined sentence in eight out of twelve items allows us to assume that participants interpreted the second sentence as stating a specific case included in the general statement in the first sentence. In the remainder third of the items, however, we can't exclude the possibility that participants

interpreted the underlined continuation as an exception rather than a specific case consistent with the more general claim. In this case, we would predict a bigger variety of scores for the 'over' condition of all three numeral modifiers. Indeed, the boxplots in Figure 2b below show that the four items that had no anaphoric terms in the second, underlined sentence received a great range of scores in all three numeral modifier conditions in the 'over' condition, which was remarkably greater especially for *to poli* 'at most' and *lighotero apo* 'less than' compared to the items with anaphora, depicted in Figure 2a. Note also that the only difference between the overall scores presented in Figure 1 and those for the items with anaphora in Figure 2a is the drop in scores for the *lighotero apo* 'less than' items in the 'over' condition. If anything, this implies an even stronger difference between *lighotero apo* 'less than' and *mehri* 'up to' when the number in the continuation is greater than the number in the first sentence.

(a) Items with anaphora   (b) Items without anaphora
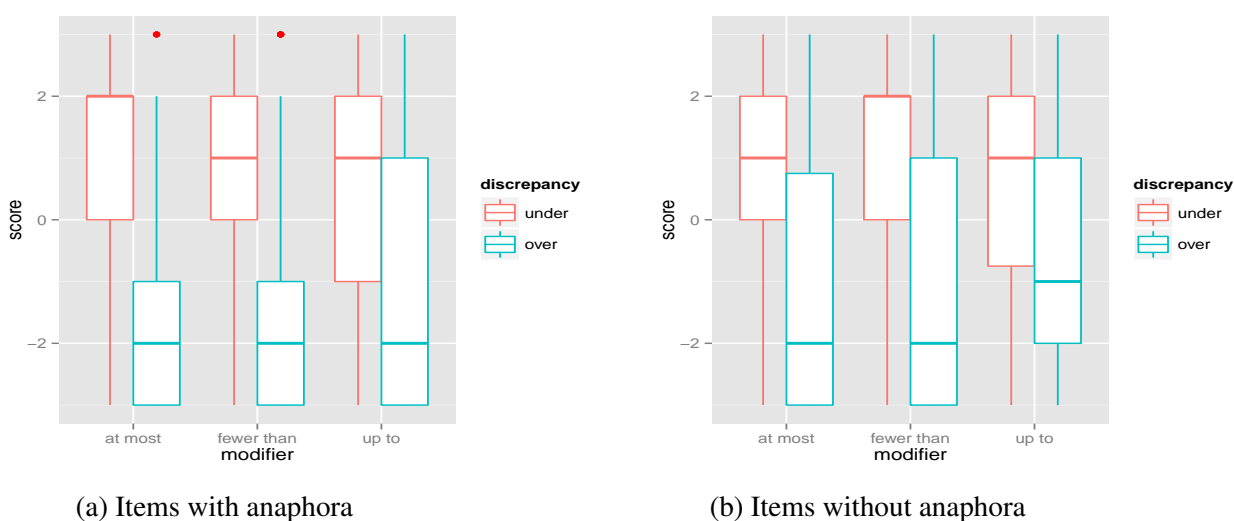
Figure 2: Coherence scores per numeral modifier in the 'under' and 'over' conditions for items with/without anaphora in the continuation sentence

Hence, the scores for the 'over' conditions show a clear difference between *mehri* 'up to' on the one hand and *to poli* 'at most' and *lighotero apo* 'less than' on the other hand. The consistently low scores for a sentence continuation with *to poli* 'at most' and *lighotero apo* 'less than' strongly suggest that these numeral modifiers specify an uncancellable upper bound and therefore a continuation with a greater number than the modified numeral is considered a "very bad continuation." In contrast, the significantly higher scores for a sentence continuation with *mehri* 'up to' strongly suggest that the upper bound the numeral modifier *mehri* 'up to' specifies is cancellable, a hallmark property of generalized conversational implicature (Grice, 1975). These results are in favour of Blok (2015), who argues that the upper bound specified by *up to* cross-linguistically is derived pragmatically via scalar implicature, whereas the upper bound specified by *at most* and *less/fewer than*, and their counterparts is part of the semantic content.

The scores for the 'under' condition are puzzling: scores for items with *mehri* 'up to' received significantly lower coherence scores than items with *to poli* 'at most' and their difference from *lighotero apo* 'less than' items was borderline significant. If the semantics of *up to* in Blok's cross-linguistic account is correct, then the fact interns in advertisement companies get up to 980 dollars per month is compatible with interns in some of these companies making (only) 950 dollars. But if this semantics is correct, then why is such a sequence of sentences with *mehri* 'up to', see translation in (12), less coherent than the same sequence with *to poli* 'at most' or *lighotero apo* 'less than', translated in (13)?

(12)   Interns in advertisement companies get up to 980 dollars per month;
         the interns in some of them are paid 950 dollars per month.

(13)   Interns in advertisement companies get $\left\{ \begin{array}{l} \text{at most} \\ \text{less than} \end{array} \right\}$ 980 dollars per month;
         the interns in some of them are paid 950 dollars per month.

Our hypothesis is that this difference between these numeral modifiers has to do with their monotonicity and how it relates to the expected continuation in discourse. Recall from the discussion in Section 2.4 that both *at most* and *less/fewer than* are monotone decreasing. In contrast with these two numeral modifiers, Blok (2015) argues that *up to* and its counterparts assert a lower-bound, which leads to a monotone-*increasing* semantics. In addition to the entailment patterns of the modifiers, there seems to be some distinct inference a listener would make regarding the expectation of the interlocutors given the use of one of these numeral modifiers that correlates with monotonicity: Upward monotonicity is correlated with the expectation that higher amounts be paid to interns and downward monotonicity is correlated with the expectation that lower amounts be paid to interns (Nouwen, 2006). The use of *mehri* 'up to', by virtue of it being upward monotone, leads participants to construct an expectation in which higher payments for interns is what is expected. Given this expectation, a lower amount as an example of one of the cases is incoherent, as it goes in the opposite direction of that expectation—even though lower amounts (above 0) are entailed. The opposite can be said of *to poli* 'at most' or *lighotero apo* 'less than', in which a constructed question under discussion would be that lower payments are expected. Given that expectation, a lower amount as an example of a specific case is coherent.

There is an alternative interpretation for the lower coherence of follow-up statements with lower numbers after statements with *mehri* 'up to', pointed out to us by Brian Buccola (p.c.). Recall that *up to n* asserts the existence of values between some implicit, contextually-salient lower bound above 0 and *n*. Since the number modified by *up to* is above a certain contextually-salient standard, the resulting inference is that this number is considerably or notably high (for the entities counted). Given the focus on the notable height of the number in question, it will be difficult to find a coherent connection to a subsequent sentence that mentions a specific case in which the number was lower.

Note, however, that similarly to the ability to comment on the evaluative adjective *nice* in (14), a speaker can contest the evaluative component of *up to three* in (15), but can't do the same when (15a) includes *at most three* or possibly even just *three* instead. (Cf. *three whole displays*, which does license (15b).)

(14)   a.   The CEO is very nice.
             b.   No she's not! She's condescending and impatient.

(15)   a.   With the Mac Pro, you can connect $\left\{ \begin{matrix} \text{\# at most} \\ \text{up to} \\ \text{? --} \end{matrix} \right\}$ three 4K displays at once.
             b.   Pfff, three is not such a large number of displays. With a DisplayLink adapter you can connect six monitors to you PC or Mac.

We leave the characteristics of evaluativity evoked by some modifier numerals to future research. In what follows, however, we address the confound introduced by the sentence continuation structure in the Greek stimuli and examine additional factors that may affect the likelihood of upper-bound construals in a follow-up experiment.

4. Experiment 2: English

4.1. Motivation

The findings of Experiment 1 are compatible with Blok's (2015) claim that the upper-bound construal of *up to* cross-linguistically is pragmatically-derived, while *at most* and *less/fewer than*'s is part of the semantic content. In Experiment 2, we make a few modifications. First, we avoid the confound introduced by sentence continuations that lead to a mismatch in expectations by presenting two independent statements which participants have to rate the compatibility of. Second, we examined the effect of scalar distance on the likelihood of upper-bound inferences. Previous studies of scalar implicatures show that a greater distance between alternate values on the scale leads to stronger implicature (Beltrama and Xiang, 2013; van Tiel et al., 2016). If *up to* leads to scalar implicature, then we would expect a similar effect on its strength. Third, we systematically controlled for the roundness of the modified numerals.

4.2. Methods

In the experimental task, we asked subjects to rate to what extent a CLAIM was compatible with a subsequently-provided FACT on a modified Likert scale of -3 to 3, where -3 was "completely

incompatible" and 3 was "completely compatible," as illustrated in the example stimulus in (16). The first statement, the CLAIM, was adapted from naturally occurring tokens gleaned from COCA (Davies, 2008). The CLAIM included one of the three numeral modifiers under investigation and a non-round number. The FACT was a more specific statement about one of the cases the CLAIM was referring to, and included a number as well, which was slightly smaller than the number in the CLAIM ($m_{fact} = n_{claim} * 0.95$; the 'under' condition), much smaller than the number in the CLAIM ($m_{fact} = n_{claim} * 0.25$; the 'way under' condition), slightly greater than the number in the CLAIM ($m_{fact} = n_{claim} * 1.05$; the 'over' condition), or much greater than the number in the CLAIM ($m_{fact} = n_{claim} * 1.75$; the 'way over' condition).

(16)   Example target item:

CLAIM: Clarendon High School used its smart classrooms 50 times last year with $\left\{ \begin{array}{c} \text{fewer than} \\ \text{at most} \\ \text{up to} \end{array} \right\}$

39 students participating in this classroom environment.
FACT: On one occasion, the smart classroom was used at Clarendon High School last year, $\left\{ \begin{array}{c} 10 \\ 37 \\ 41 \\ 68 \end{array} \right\}$ students participated.

How compatible is the CLAIM with the FACT?

$$-3 \quad -2 \quad -1 \quad 0 \quad 1 \quad 2 \quad 3$$

completely   completely
incompatible   compatible

All target items (N=30) were rotated through 15 lists in a latin square design, so that each participant only saw one condition per item. 30 filler items including 10 contradictions, 10 entailments and 10 scalar implicatures involving a quantifier were added into the mix, too. In the contradiction items, a quantifier like *a couple of* in the CLAIM, as in (17), was contrasted with a quantifier *none* in the FACT, as in (17a). In the entailment items it was contrasted with the quantifier *some* in the FACT, see (17b). And in the implicature items, it was contrasted with the quantifier *all*, as in (17c).

(17)   Example of filler items:
CLAIM: The New York Daily News reports that **a couple of** the of the pill bottles were not labeled and were probably older prescriptions.

   a.   Contradiction:
        FACT: **None** of the pill bottles were older prescriptions.
   b.   Entailment:
        FACT: **Some** of the pill bottles were older prescriptions.

    c.   Implicature:
        FACT: **All** of the pill bottles were older prescriptions.

90 declared native speakers of English participated in the experiment on Amazon's Mechanical Turk. Data from six participants were discarded, because they gave scores greater than -1 to the contradiction items and smaller than 1 to the entailment items. Data from the remaining 84 participants (58 female participants; mean age: 38.73; age range: 21–54) were used to the statistical analyses reported on here.

4.3. Results

Similarly to Experiment 1, the data were analyzed with mixed-effects ordered probit regression models using the `ordinal R` package (Christensen, 2013). The full model with type of modified numeral, discrepancy, and their interaction as fixed effects with random intercepts and slopes for modifier, discrepancy, and their interaction for subjects, and with random intercepts and slope for items was found to be the best fit for our data ($LRstatistic = 43.61$, $df = 14$, $p < .001$). Setting LESS/FEWER THAN and WAY UNDER as reference levels, we found that overall scores for items with *up to* were significantly different from items with *less/fewer than* ($\beta = 2.43$, $SE = .20$, $p < .01$) but we found no significant difference between items with *at most* and items with *less/fewer than* ($\beta = .26$, $SE = .20$, $p = .16$). In addition, we found a significant difference between the 'way under' condition and the 'over' ($\beta = -6.61$, $SE = .25$, $p < .0001$) and 'way over' ($\beta = -7.09$, $SE = .25$, $p < .0001$) condition, and marginally significant difference between the 'way under' and 'under' conditions ($\beta = .34$, $SE = .19$, $p = .08$). We found a significant interaction for *up to* and 'over' ($\beta = 2.41$, $SE = .28$, $p < .001$) and marginally significant interaction for *up to* and 'way over' ($\beta = .50$, $SE = .27$, $p = .006$).

We further explored these effects with four additional models, each consisting of one of the four discrepancy conditions ('way under', 'under', 'over,' and 'way over'). All four models had modifier as the only fixed effect. Similarly to Experiment 1, in the 'over' condition, items with *up to* received significantly higher compatibility rates than items with *less/fewer than* ($\beta = 2.03$, $SE = .20$, $p < .01$) and items with *at most* ($\beta = 2.25$, $SE = .20$, $p < .01$). In the 'way over' condition, items with *up to* received significantly higher compatibility rates than items with *less/fewer than* ($\beta = .49$, $SE = .186$, $p < .01$ and items with *at most* ($\beta = .51$, $SE = .18$, $p = .01$).

Finally, we ran three additional models, each consisting of one of the three numeral modifiers (*less/fewer than, at most* and *up to*). For each modifier, items in the 'way over' condition were significantly less coherent than items in the 'over' condition (*less/fewer than*: $\beta = -.46$, $SE = .18$, $p < .05$; *at most*: $\beta = -.95$, $SE = .37$, $p < .01$; *up to*: $\beta = -2.18$, $SE = .26$, $p < .01$). There were no differences between the ratings for the 'under' and 'way under' conditions for any of the modifiers and among them.
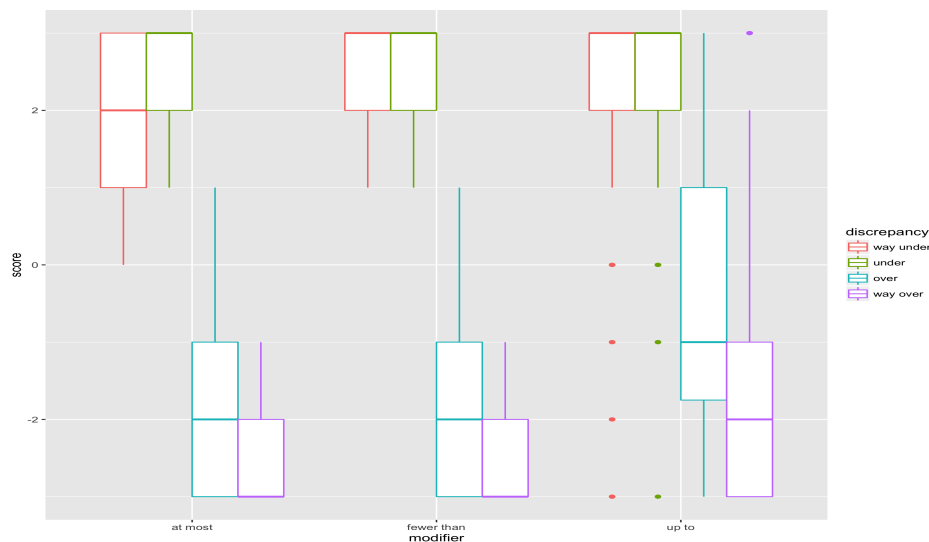
Figure 3: Compatibility scores per numeral modifier in Experiment 2

4.4. Discussion

In Experiment 2, too, a clear difference between *up to* on the one hand and *at most* and *less/fewer than* on the other hand in the 'over' condition strongly suggests that *up to*'s upper bound is far more cancellable, while *at most* and *less/fewer than*'s upper bound is hard to cancel. This is in line with Blok (2015), according to which the upper bound of *up to* is derived via a pragmatic mechanism, while the upper bound of *at most* is derived as an entailment. The small range of scores *at most* received as compared to the large range of scores for *up to* further strengthens this contrast.

Given that the upper bound imposed by *at most* and *less/fewer than* seems to be semantic, we would expect it to be impervious to contextual factors such as the scalar distance of the value above the number specified by *at most/less than n*, in contrast with the pragmatically-derived upper bound communicated by *up to*, which would be more sensitive to contextual factors, similarly to other types of scalar implicature (Doran et al., 2009; Degen, 2015). While we indeed found that greater values in the FACT led to significantly lower rates in CLAIMs with *up to*, we were surprised to find the same difference for CLAIMs with *at most* and for CLAIMs with *less/fewer than*.

The source of the effect between the 'over' and 'way over' conditions can either be the same for all numeral modifiers or be different for *at most* and *less/fewer than* on the one hand and *up to* on the other. If the source of the effect is the same for all numeral modifiers, then what is at play here isn't contextual factors, as the upper bound imposed by *at most* and *less/fewer than* is semantic. What is possibly the case here is that participants mapped the numeral scale onto the Likert scale used in the task. That is, the numbers in the CLAIM both in the 'over' and 'way over' condition were

equally incompatible with the number in the FACT, but the greater distance between the numbers in the 'way over' condition led participants to mark the numerical difference irrespective of the fact that the FACTs in both the 'over' and 'way over' condition were false.

Another possibility is that a great difference between the value in the CLAIM vs. the one in the FACT seems to violate Relevance: If I know of a case in which ≤ 68 students participated in the smart classroom (see FACT in (18)), why would I utter a general claim with a much smaller number (e.g., 39 in CLAIM below), let alone a number that points to a fine level of granularity with no pragmatic slack to allow for a larger range of possible values (cf. 40)?

(18)   CLAIM: Clarendon High School used its smart classrooms 50 times last year with $\left\{ \begin{array}{c} \text{fewer than} \\ \text{at most} \\ \text{up to} \end{array} \right\}$

39 students participating in this classroom environment.
FACT: On one occasion, the smart classroom was used at Clarendon High School last year, 68 students participated.

In sum, the lower rates for the 'way over' condition could be driven by the violation of Relevance. Although the compatibility rates decrease for all numeral modifiers, the combination of different semantic and pragmatic factors lead to what seems like a similar behaviour. Future studies would be required to tease apart the role of the numeral scale, the scalar distance, granularity, and relevance on the inferences speakers draw from utterances with numeral modifiers.

5. Conclusion

Taken together, the results from the two experiments show that upper-bound construals are more likely in superlative modifiers, like *at most* and *to poli* 'at most', and comparative modifiers, like *less/fewer than* and *lighotero apo* 'less than', than they are for directional modifiers, like *up to* and *mehri* 'up to', suggesting that this contrast is due to the difference in how the upper bound is derived: in superlative and comparative numeral modifiers it is derived from the lexical semantics, whereas in *up to* it is derived as a pragmatic inference, supporting Blok's (2015) account.

In the second experiment we show that the upper-bound implicature is sensitive to an additional contextual factor, namely the scalar distance between possible alternatives and the number modified and asserted. This ties in with previous theoretical and experimental studies that show that the distance of alternatives on an entailment-based scale affects the likelihood of an upper-bound construal (Horn, 1972; Beltrama and Xiang, 2013; van Tiel et al., 2016).

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Toward a General Theory of Nonlocal Readings of Adjectives[1]

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Abstract. Adverbial readings of adjectives (as in *The occasional sailor strolled by*) have been a longstanding curiosity, but are often thought peripheral and idiosyncratic. This paper argues that such nonlocal readings are both more common and more systematic than previously recognized. The empirical aim here is to demonstrate that despite some real idiosyncrasies, the regularities are sufficient to require a unified account. Adjectives that give rise to these readings fall into three classes distinguished by the restrictions they impose on the quantificational force of their determiner. These restrictions and the unexpected wide scope of the adjective can both be explained by assuming that the relevant adjectives are quantificational, trigger QR from inside the DP, and leave behind a type-shifted trace.

Keywords: adjectives, nonlocal readings, scope, occasional construction, average.

1. Introduction

One of the stranger properties of certain adjectives is that they are sometimes interpreted as though they weren't adjectives at all. The best-studied case of this involves so-called adverbial readings of *occasional* and related frequency adjectives (Bolinger 1967, Stump 1981, Larson 1999, Zimmermann 2003, Schäfer 2007, Gehrke and McNally 2010, DeVries 2010), illustrated in (1):

(1) An occasional sailor strolled by.
    a. *internal*: 'Someone who sails occasionally strolled by.'
    b. *external*: 'Occasionally, a sailor strolled by.'

The well-behaved reading is the one in (1a), called the internal reading. The odder and therefore more interesting one is in (1b), the external or adverbial reading, where the adjective contributes a semantics that would normally be associated with an adverb. This could be framed as a scope puzzle: why does the adjective apparently take scope outside its DP? A number of additional puzzles arise as well, including the rather mysterious fact that (1b) would mean precisely the same thing on the external reading if *an* were replaced with *the*.

This phenomenon and the *occasional* construction more generally are sometimes regarded as a kind of grammatical curiosity, vexing and interesting, but probably peripheral and idiosyncratic. My aim here will be to demonstrate that the opposite is true: they are in fact the tip of a much larger iceberg. Such readings are both far more common and more systematic than has been gener-

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ally recognized. Larson (1999) and Schwarz (2006, to appear) point out a number of connections among them and take a broader analytical outlook. Apart from that, though, such nonlocal readings of adjectives (I borrow the term from Schwarz) typically remain unobserved or are given an independent explanation for every lexical-semantic flavor of adjective that manifests them. But although there is some real quirkiness in this domain, the regularities are sufficiently numerous and robust to require a unified analysis.

Section 2 will identify some of these regularities across several lexical classes of adjective and make the case for their pervasiveness. They encompass *average/typical* (Kennedy and Stanley 2009), *wrong* (Haïk 1985, Schwarz 2006, to appear), *whole/entire* (Moltmann 1997, 2005, Morzycki 2002), *possible* and its kin (Larson 2000, Schwarz 2005, Romero 2013, Leffel 2014), *unknown* and its kin (Abusch and Rooth 1997), and perhaps even *same* and *different* (Nunberg 1984, Heim 1985, Carlson 1987, Keenan 1992, Moltmann 1992, Beck 2000, Lasersohn 2000, Majewski 2002, Alrenga 2006, 2007a, b, Barker 2007, Brasoveanu 2011) – and there are others still. Section 3 will discern in the data some patterns according to which adjectives with nonlocal readings can be grouped into three classes according to the restrictions they impose on the quantificational force of their determiner. I'll call these the ellipsis class, the weak-determiner class, and the quantifier-resistant class. Section 4 will sketch an analysis of a few adjectives with an eye to elucidating the properties of these classes in a generalizable way. The theoretical claims on which this analysis is built are that the relevant adjectives are quantificational, trigger Quantifier Raising from inside the DP, and leave behind a type-shifted trace. The determiner restrictions and unexpected wide scope follow. Section 5 concludes.

2. Nonlocal readings are widespread

2.1. Frequency adjectives and common properties of nonlocal readings

To identify the properties that nonlocal readings share, it helps to first consider *occasional*, the paradigm case, in some detail. We've already briefly encountered three of such properties: the unexpectedly wide-scope interpretation, the internal/external ambiguity, and an unexpected interpretation of the determiner.

On that last point, more should be said. As already noted, on the external reading, *a* and *the* mean more or less – and perhaps precisely – the same thing. But worse, *your* seems to have this meaning as well:

(2)   {An/The/Your} occasional sailor strolled by.
        'Occasionally, a sailor strolled by.'

This observation is widely made in the literature on this construction (Bolinger 1967, Stump 1981, Larson 1999, Zimmermann 2003, Schäfer 2007, Gehrke and McNally 2010, 2015, DeVries 2010), but for the most part is treated as something that must ultimately be stipulated (Gehrke and Mc-

Nally 2010 being notable exceptions). Other frequency adjectives, such as *infrequent* (*An infrequent visitor was seen*) and *sporadic* (*A sporadic shot was fired*) behave more or less similarly (Larson 1999).

There is further odd determiner behavior to be recognized, though. With most other determiners, the external reading is unavailable:

(3)   {Every/Some/Several/Many/Most} occasional sailor(s) strolled by.
    a.   *internal*: '*D* person/people who sail(s) occasionally strolled by.'
    b.   #*external*: 'Occasionally, *D* sailor(s) strolled by.'

For the sake of having a convenient label, I'll refer to these determiners as 'inherently quantificational'. I mean this, for the moment, as a pretheoretical descriptive term for determiners other than *the* and *a*, making no commitments about how this distinction should be cashed out.[2] It is, of course, not at all clear why the external reading should disappear here. Conceptually, there is absolutely nothing wrong with what (3), on the external reading, would be trying to mean.

Another restriction on the external reading concerns the position of the adjective relative to other adjectives. If *occasional* (or other frequency adjective) occurs leftmost in a sequence of adjectives – and therefore presumably in a structurally higher position – both readings are possible:

(4)   The occasional angry sailor strolled by.
    a.   *internal*: 'Someone angry who sails occasionally strolled by.'
    b.   *external*: 'Occasionally, an angry sailor strolled by.'

When another adjective occurs above it, however, the external reading is lost:

(5)   The angry occasional sailor strolled by.
    a.   *internal*: 'Someone angry who sails occasionally strolled by.'
    b.   #*external*: 'Occasionally, an angry sailor strolled by.'

The external reading is also absent in coordinate structures:

(6)   The occasional and angry sailor strolled by.
    a.   *internal*: 'Someone angry who sails occasionally strolled by.'
    b.   #*external*: 'Occasionally, an angry sailor strolled by.'

It is also absent when the adjective hosts a degree modifiers:

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[2]The most straightforward option would probably be to adopt a DRT/File Change Semantics (Kamp 1981, Heim 1982) conception of definiteness, in which *a* and *the* have no quantificational force of their own. On this view, though, it would seem more than slightly mysterious that *this* and *that* also don't support external readings

(7)   The very occasional sailor strolled by.
        a.   *internal*: 'Someone who sails very occasionally strolled by.'
        b.   #*external*: 'Very occasionally, a sailor strolled by.'

2.2. 'Average'

There is a longstanding linguistic and philosophical debate around the semantics of *average* and *typical*, chiefly because of sentences like (8) (Carlson and Pelletier 2002, Kennedy and Stanley 2009):

(8)   An average American has 2.3 children.

The problem is usually taken to be one of reference: to what do *an average American* and *2.3 children* refer? But as Kennedy and Stanley (2009) observe, one might view this as a compositional problem rather than as an issue of reference. That's what's most relevant here, because it turns out that this construction has all the signature features of the *occasional* construction noted above.

First, there is an internal/external ambiguity:

(9)   An average American has 2 children.
        a.   *internal*: 'An American, who is typical, has 2 children.'
        b.   *external*: 'On average, an American has 2 children.'

Second, there are unexpected interpretations of the determiner, and in precisely the same way as for *occasional*. *A*, *the*, and *your* all wind up meaning the same thing:

(10)   {The/Your} average American has 2 children.
        a.   *internal*: '{The/Your} American that's a typical one has 2 children.'
        b.   *external*: 'On average, an American has 2 children.'

Third, on the external reading, the same restriction is imposed against other determiners:

(11)   #{Every/Most/Some/Several/Two} average American(s) {has/have} 2.3 children.

Here, I've exploited the convenient fact that *2.3 children* normally forces the external reading. On the internal reading, it would require that there be a plurality of children 2.3 children, counterpragmatically. This reading is in fact possible if we assume the existence partial children. Fourth, as before, external readings are available only when *average*/*typical* is leftmost in a string of adjectives:

(12)   a.   An average irritable American has 2.3 children.
        b.   #?An irritable average American has 2.3 children.

Again, (12b) has only the internal reading and therefore requires recognizing fractional children. Fifth, as before, the external reading is lost in coordinate structures:

(13)   #An irritable and average American has 2.3 children.

Sixth, it's also lost in the presence of degree modification:

(14)   #A very average American has 2.3 children.

2.3. 'Wrong'

The version of the now-familiar pattern emerges once again with *wrong* (Haïk 1985, Schwarz 2006, to appear). It too has an internal/external ambiguity, though perceiving it is slightly trickier. Suppose Floyd is a spy who is required to provide his interlocutor with false information and deprive her of true information. If he succeeds in this, (15) is true on the internal reading, on which the information provided was incorrect:

(15)   Floyd gave the wrong answer.
        a. *internal*: 'Floyd gave an answer that was incorrect.'
        b. *external*: 'Floyd gave an answer that it was wrong of him to give.'

On the external reading, (15) is false, because Floyd answered as he is supposed to. On the other hand, if Floyd slips up at some point and accidentally answers a question truthfully, the situation is flipped: (15) is still true, but only on the external reading: he provided information that he isn't supposed to provide, namely, true information. Something similar happens in (16):

(16)   Floyd killed the wrong person.
        a. *internal*: 'Floyd killed a person that was just a wrong person in general.'
        b. *external*: 'Floyd killed a person that it was wrong of him to kill.'

There is again an odd fact about the interpretation of the determiner: *the* is interpreted as an indefinite. In (15), there need not have been only one wrong answer, and in (16), there need not have been only one person who must not be killed. The picture is slightly different, though. *Your* is impossible here except on its usual possessive reading, irrelevant here:

(17)   a. ?Floyd gave your wrong answer.
        b. ?Floyd killed your wrong person.

Strangely, it's not just that the definite determiner is interpreted as an indefinite, but it's the principal way to say this. The indefinite would be unusual on the external reading:

(18)   a. Floyd gave a wrong answer.
        b. Floyd killed a wrong person.

It's not actually fully clear what reading these receive. For me, an external reading is possible, but only when there is a desire to communicate that there there are many answers that shouldn't be given and people that shouldn't be killed.

Apart from that quirk, again we encounter restrictions on the choice of determiner on the external reading:

(19)   #Floyd opened {every/most/some/several/two} wrong envelope.

As before, inherently quantificational determiners fail.

The requirement that the nonlocal adjective be structurally higher than other adjectives again emerges:

(20)   a.   Floyd opened the wrong brown envelope.
        b. #Floyd opened the brown wrong envelope.

So does the ban on coordination:

(21)   #Floyd opened the wrong and brown envelope.

And so does the ban on degree modification:

(22)   #Floyd opened the very wrong envelope.

2.4. 'Whole' and 'entire'

The parallels continue with *whole* and *entire*, though there will be an important twist. As before, there is an ambiguity (Moltmann 1997, 2005, Morzycki 2002), which I'll assume is a special case of the internal/external ambiguity:

(23)   A whole ship was submerged.
        a. *internal*: 'A complete, structurally intact ship was submerged.'
        b. *external*: 'A ship was wholly submerged.'

(24)   The whole apple is terrible.
        a. *internal*: 'The complete, structurally intact apple, the one with no bites taken out of it, is terrible.'
        b. *external*: 'All parts of the apple are terrible.'

The internal reading is actually the unusual one in these cases, and may take a moment to perceive. It's what could be expressed more or less unambiguously with *complete* – indeed, I suspect that it's

precisely the existence of this unambiguous alternative that accounts (on broadly Gricean grounds) for the unnaturalness of the internal reading.

As before, there are restrictions on the determiner, but they take a different form. First, *a*, *the*, and *your* retain their usual meanings, and don't become interchangeable. Second, strong quantifiers are still incompatible with the external reading, but weak ones are perfectly compatible with it:

(25)   a. $\left\{ \begin{array}{l} \text{\#Every/\#Most} \\ \text{Many/Several/Two} \end{array} \right\}$ whole ship(s) $\left\{ \begin{array}{l} \text{was} \\ \text{were} \end{array} \right\}$ submerged.

        b. $\left\{ \begin{array}{l} \text{\#Every/\#Most} \\ \text{Many/Several/Two} \end{array} \right\}$ whole apple(s) $\left\{ \begin{array}{l} \text{is} \\ \text{are} \end{array} \right\}$ terrible.

The other, now increasingly familiar restrictions reemerge in their customary form. The external reading is only possible when the nonlocal adjective occurs high (I will now indulge in the habit of marking sentences with a #when they are impossible on the external reading):

(26)   a.   A whole enormous ship was submerged.
        b. #An enormous whole ship was submerged.

It's incompatible with coordination:

(27)   A whole and enormous ship was submerged.

And it's incompatible with degree modification:

(28)   #An entirely whole ship was submerged.

2.5. Epistemic adjectives

Abusch and Rooth (1997) observed a proposition-modifying interpretation of what they called 'epistemic adjectives' that, in the current context, won't come as a shock. These adjectives include *unknown*, *undisclosed*, *unspecified*, and *unexpected*. They can receive

(29)   Solange is staying at an unknown hotel.   (Abusch and Rooth 1997)
        a. *internal*: 'Solange is staying at a hotel no one has heard of.'
        b. *external*: 'Solange is staying at a hotel and it is not known which hotel she is staying at.'

At this point, the reader is invited to sing along, because we will again encounter the same analytical refrain. On the external reading, there are again restrictions on the determiner. Although *the* and *a* seem to behave normally, strong inherently quantificational determiners remain impossible:

(30)   Solange stayed at {#every/#most/some/several/two} unknown hotel(s).

As for *whole*, weak determiners are compatible with external readings.

The restrictions on the structural position of the adjective in the DP remain the same. The external reading is, as we have come to expect, possible only when the adjective is high:

(31) a. Solange stayed at a horrible unknown hotel.
      b. #Solange stayed at a unknown horrible hotel.

The external reading is unavailable when the adjective occurs in a coordinate structure:

(32) #Solange stayed at a horrible and unknown hotel.

It's incompatible with degree modification:

(33) #Solange stayed at a very unknown hotel.

2.6. 'Same' and 'different'

Other adjectives fall under broadly the same rubric. Among the best-studied of these are *same* and *different* (Nunberg 1984, Heim 1985, Carlson 1987, Keenan 1992, Moltmann 1992, Beck 2000, Lasersohn 2000, Majewski 2002, Alrenga 2006, 2007a, b, Barker 2007, Brasoveanu 2011). The facts in this domain are complicated in ways that muddy the waters considerably, but for our purposes the important point is that there is an ambiguity:[3]

(34) Floyd and Clyde read the same book.
      a. *internal (anaphoric)*: 'Floyd and Clyde read a book that is the same as the one previously mentioned.'
      b. *external*: 'Floyd and Clyde read a book in common.'

(35) Floyd and Clyde read a different book.
      a. *internal (anaphoric)*: 'Floyd and Clyde read a book that is the different from the one previously mentioned.'
      b. *external*: 'The book Floyd read was not the same book as the one Clyde read.'

The discourse-dependent anaphoric reading counts as internal in the sense that it doesn't require the adjective to scope outside the DP.

I won't rehearse the full song-and-dance. Suffice it to say that on the external reading, *same* and *different* impose restrictions on the determiner with which they combine:

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[3]The term 'internal' is actually used by Carlson for one of these readings, but given our taxonomy it would be the internal one.

(36)   #Floyd and Clyde read {every/most/some/several/two} same book(s).

And on this reading *same* and *different* are subject to a structural position requirement:

(37)   a.   Floyd and Clyde read the same good book.
       b.   *Floyd and Clyde read the good same book.

2.7. Modal superlatives: the possible class

There is another important class of nonlocal readings of adjectives, which I will mostly set aside. These involve *possible*, *conceivable*, and the like ('modal superlatives'; Bolinger 1967, Larson 2000, Schwarz 2005, Cinque 2010, Romero 2013, Leffel 2014):

(38)   They interviewed every possible candidate.
       a. *external*: 'They interviewed every candidate that it was possible to interview.'
       b. *internal*: 'They interviewed every person who was possibly a candidate.'

There are important distinctions between these cases and the ones we've examined so far, but for the moment I will note only the similarity: again, there is an ambiguity between an internal and external reading.

2.8. Miscellaneous obscurities and novelties

Without further discussion, I'll note a few examples of nonlocal readings that are either obscure or, to my knowledge, novel:

(39)   The inevitable counterexample arose.
       'Inevitably, a counterexample arose.'

(40)   He spooned a moody forkful.   (P.G. Wodehouse; Hall 1973)
       'Moodily, he spooned a forkful.'

(41)   An unlikely chiropractor discovered the solution.
       'A chiropractor discovered the solution and it was unlikely that that chiropractor (or a chiropractor?) would do so.'

(42)   Clyde asked a random linguist.
       'Clyde asked a linguist randomly.'

(43)   Floyd received an unfortunate grade.
       'Floyd received a grade such that it was unfortunate to receive it.'

One shouldn't read too much into these without careful examination, of course, but they collectively suggest that more external readings lurk just over our analytical horizon.

3. Patterns and subclasses

It's possible to digest the patterns we've so far encountered a bit further. Although there is a lot of heterogeneity among nonlocal readings, there is also order amid the chaos. What emerges are three different patterns, and therefore three different classes of nonlocal adjectives:

(44)   a. the quantifier-resistant class: *occasional, average*
       b. the weak-determiner class: *whole*, *unknown*
       c. the ellipsis class: *possible*, *conceivable*

The last of these, the ellipsis class, has been mostly set aside here, and I don't propose to change that, but a few words are in order about why setting it aside is reasonable. The essential reason is that this class is weird even from the point of view of the other nonlocal readings. It simply doesn't seem to fit into the bigger picture. Unlike all other nonlocal adjectives, it is not only compatible with *every*, but actually requires it or else *only* or a superlative:

(45)   We interviewed $\left\{ \begin{array}{l} \text{every/the only/the best} \\ \text{\#the/\#a/\#no/\#three} \end{array} \right\} \left\{ \begin{array}{l} \text{possible} \\ \text{conceivable} \end{array} \right\}$ candidate.

It is also amenable to an enlightening analysis quite different from any that would suffice for the other groups. As the name I have adopted suggests, the crucial element of this analysis is ellipsis. Larson (2000) argues persuasively that at some level of representation there is an elided constituent:

(46)   We interviewed the best candidate possible ~~for us to interview~~.

Romero (2013) shows that an account in this spirit can actually be built from standard assumptions about superlatives. These readings have been largely demystified, but an explanation along these lines is a non-starter for the other classes. Indeed, one might wonder whether the nonlocal readings involved in these ellipsis cases are really 'nonlocal' in the same sense.

Setting these cases aside, all nonlocal readings observe a generalization:

(47)   *Strong Quantifier Generalization*
       Strong, inherently quantificational determiners (*every, most, no*) are incompatible with nonlocal readings.

This has been observed for specific lexical-semantic families of adjectives, but the important point is that it seems to be true of all of them.

As we've seen, a few nonlocal adjectives – *occasional*, *average*, and *wrong* – are even more constrained in that they are incompatible with any determiner apart from (some combination of) *the*, *a*,

and generic *your*. Stating it more officially:

(48)   *Quantifier Resistance Generalization*
       Some adjectives with nonlocal readings idiosyncratically resist all inherently
       quantificational determiners.

Of course, the challenge now is to explain these generalizations. That's a tall order, inasmuch as it requires a synthesis of a vast array of adjectives and (collectively) a vast literature and set of analytical approaches. This won't happen in any single paper. Nevertheless, having framed the challenge in this way, we are in a better position to assess what an explanation might look like.

4. Determiner-like adjectives

4.1. Incorporation

First, we must dispense with a straw man. One might imagine that external readings of adjectives are brought about simply by moving the adjective from its base position to an adverbial position, where it is interpreted as an adverb. The idea is a natural one, and I'll argue that in a certain sense it's not entirely wrong – but formulated in this crude way, it's unenlightening. Why should this movement happen? Why would an adjective have an adverb meaning? How does this help us understand the interaction of the adjective with the determiner?

More enlightening alternatives are available. There are of course many analyses on the market of specific parts of the larger problem of nonlocal readings, but most aren't straightforwardly generalizable in a way that might account for the generalizations we seek to explain. There is one idea, though, that is constitutes an excellent starting point. It's Larson (1999) and Zimmermann (2000, 2003) proposal that, in the *occasional* construction, the adjective incorporates into the determiner in a process of 'complex quantifier formation'. This movement creates a single quantificational determiner, *an+occasional*. It is then possible to provide this determiner with a denotation, listed in the lexicon just like that of any other. The advantage of that is that it's straightforward to capture various idiosyncrasies. If we need to stipulate that for *occasional* and *average*, the denotations of *the*, *a*, and *your* should be identical but for *wrong* they shouldn't be, we can reflect it directly. Indeed, we should *expect* such idiosyncrasies, inasmuch as the lexicon is, after all, a repository of the idiosyncratic. Less comfortable is that we have to stipulate not only that *an+occasional*, *the+occasional*, and *your+occasional* all have identical denotations, but also do so independently for *a+sporadic*, *the+sporadic*, and *the+sporadic* – and indeed for other combinations of *a*, *the*, and *your* with adjectives of this class. The incompatibility of this construction with other determiners would could be captured simply by not stipulating a denotation for any other combination of a determiner and frequency adjective.

This approach provides helps in one way right off the bat. Quantificational determiners have access to the VP by perfectly ordinary means: QR. A generalized quantifier takes a VP as its argument,

and if an adjective is part of a quantificational determiner meaning, it will gain access to the VP as a matter of course. Thus this approach accounts for the adverbial scope of *occasional* and its kin, for the idiosyncratic interpretations of determiners in this construction, and for restrictions on the determiner. It also accounts for the restriction on coordination: any adjective in a coordinate structure would be unable to move out of it without violating the Coordinate Structure Island. The obligatory high position of the adjective is explained as well – any adjectives above it would block its path to the determiner. The incompatibility of external readings with degree modification would also be expected, because only a bare adjective, and not a phrasal constituent, can do head-to-head movement. This approach may even shed light on Zimmermann (2003)'s observation that external readings are often absent where QR is blocked. This analysis can be extended to *average*, *wrong*, perhaps *same*, and maybe others.

Nevertheless, one might have some qualms. The movement required would seem to violate the Head Movement Constraint. More worrying, perhaps, why are *a*, *the*, and *your* the determiners that have been targeted for complex quantifier formation? Could it in principle have been any other combination? And why is it that the denotations of these complex determiner-adjective combinations aren't unpredictable? If they're specified in the lexicon, one might imagine arbitrary variation, but the generalizations we would like to explain aren't arbitrary. Whatever the answers to these questions, more would have to be said to make weak-determiner-compatible adjectives such as *whole*, *unspecified*, and *different* fit in.

4.2. An alternative: determiner-like adjectives

One satisfying aspect of the incorporation analysis is that it reflects that nonlocal adjectives aren't prototypically adjective-like, even on a purely descriptive level. They don't pass standard diagnostics for adjectives, such ability to occur in comparatives, with degree modifiers, or in the complement position of *seem*. They don't conjoin with adjectives. Nor do they occur in the same positions as adjectives generally; rather, they are obligatorily high.

This might suggest incorporation or another form of syntactic differentiation, but all these properties also follow from simply assuming that nonlocal adjectives have an unusual semantic type. In the spirit of the incorporation approach, I'll assume these adjectives have quantificational determiner denotations, type $\langle et, \langle et, t \rangle \rangle$. This has as a consequence that the node above the adjective would denote a generalized quantifier, and would therefore have to QR to avoid a type clash. But in the resulting structure, the remnant DP needs help. It gives rise to a different type clash: the node to the right of *the* would be a trace, so it would denote an individual, but *the* is of type $\langle e, t \rangle$ and expects a property. A natural solution is to adopt the standard BE type shift (Partee 1987):

(49)   a. $[\![\,\text{BE}\,]\!] = \lambda x \lambda y [x = y]$

      b. $[\![\,\text{BE } x_1\,]\!] = \lambda y [x_1 = y]$

That resolves the type clash by providing *the* with the property-denoting argument in (49b). But as it turns out, it does more.

4.3. Determiners that work

One of the things we would like to explain is why *the*, *a*, and *your* seem to work robustly with a number of nonlocal adjectives, and why distinctions in their interpretations seem to be neutralized in the presence of frequency adjectives and *average/typical*. That result follows from the type shift alone. *The* would combine with the shifted trace to yield the unique individual that is identical to the one the trace denotes. Of course, that individual is always, well, that very same individual:

(50) a. $[\![\,the\,]\!] = \lambda P_{\langle e, t\rangle}.\iota y[P(y)]$

  b. $[\![\,the\,]\!]\,([\![\,\textsc{be}\,x_1\,]\!]) = \iota y[x_1 = y] = x_1$

The effect is as though *the* were absent entirely, as though the nonlocal adjective and its NP sister had occurred in subject position on their own. The semantically-bleached variant of *your* that occurs in e.g. *your average American* mostly amounts to a version of *the* with a slight whiff of genericity about it, which would leave us in more or less the same place (see Gehrke and McNally 2010, 2015 for more). As for *a*, the right result follows from the simple equivalence in (52):

(51) a. $[\![\,a\,]\!] = \lambda P_{\langle e, t\rangle}\lambda Q_{\langle e, t\rangle}.\exists x[P(x) \wedge Q(x)]$

  b. $[\![\,a\,]\!]\,([\![\,\textsc{be}\,x_1\,]\!]) = \lambda Q_{\langle e, t\rangle}.\exists x[x_1 = x \wedge Q(x)]$

(52) $\exists x[x_1 = x \wedge Q(x)] \Leftrightarrow Q(x_1)$

To say that there is an individual identical to x_1 of which the predicate Q holds is simply to say that Q holds of x_1. The result, again, is truth-conditionally identical to what would have happened had the determiner been absent entirely.

To articulate this a little bit further, let's adopt the toy denotation for *average* in (53a). This applies to the denotation of the modified NP, and predicates the VP meaning of the kind that corresponds to the NP meaning, using Chierchia (1998)'s $\cap$ property-to-kind type shift:[4]

(53) a. $[\![\,average\,]\!] = \lambda P_{\langle e, t\rangle}\lambda Q_{\langle e, t\rangle}.Q(^{\cap}P)$

  b. $[\![\,average\ American\,]\!] = \lambda Q_{\langle e, t\rangle}.Q(^{\cap}\textbf{American})$

Naturally, this isn't remotely adequate on its own as a theory of *average*, and much of Kennedy and Stanley (2009) would have to be layered on top of it. But it suffices to sketch the compositional

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[4]Given this denotation, I could have equivalently dispensed wth the λQ in the denotation of *average* and had *average American* denote a kind directly. This is possible here only because I have radically simplified the denotation, though. Ultimately, *average* would need to have access to the VP denotation.

machinery. Thus the updated tree would look like this (I've ornamented the tree with a superscript k to reflect that the trace of *average American* denotes a kind):

(54)

$$t$$

- $\langle et, t \rangle$
  - $\langle \langle et, \langle et, t \rangle \rangle \rangle$
    - *average*
  - $\langle e, t \rangle$
    - *American*
- $\langle e, t \rangle$
  - λx_1^k
  - t
    - *the* BE x_1^k *has 2.3 children*
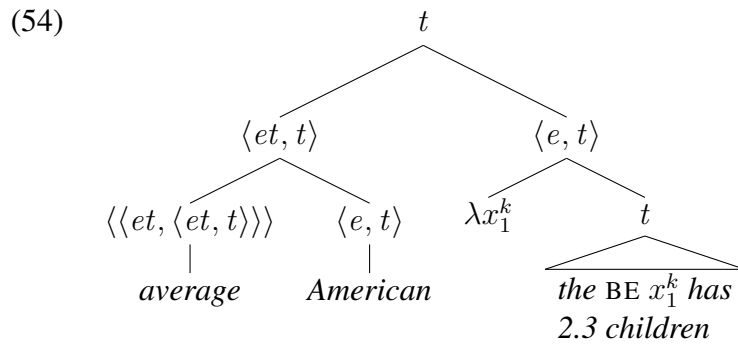
The result of the computation would be just what we need:

(55)   a. $[\![$ *the* BE x_1^k $]\!] = x_1^k$

b. $[\![$ *the* BE x_1^k *has 2.3 children* $]\!] = $ **has-2.3-children**(x_1^k)

c. $[\![$ *average American* $]\!] = \lambda Q_{\langle e,\, t \rangle}.Q(^\cap \textbf{American})$

d. $[\![$ *average American* $]\!]$ $([\![\, \lambda x_1^k$ *the [*BE x_1^k*]] has 2.3 children* $]\!])$
      $= $ **has-2.3-children**$(^\cap \textbf{American})$

4.4. Determiners that don't work

What of determiners that *don't* work? Again, the nature of the movement and resulting type shift helps the situation – or rather, undermines it in the right way. Strong determines like *every* and *most* presuppose that their domain has more than one member. (Hence the oddness of e.g. *Every guy in the corner should leave* when there is only one such guy.) In (56), *every* combines with the property $[\![$ BE x_1^k $]\!]$:

(56)   a. #Every average American has 2.3 children.

b. [average American] [λx_1^k [every [BE x_1^k]]] has 2.3 children

(57) $[\![$ BE x_1^k $]\!] = \lambda y[x_1^k = y]$

But (57) is a singleton property – there is only one individual that is identical to x_1^k. It therefore violates the presupposition *every* imposes on its first argument. *Most* would work similarly. Because movement below the DP level systematically gives rise to such singleton properties, it systematically precludes combining with strong quantifiers.

Weak determiners like *many* and *three* are also incompatible with *average* and *occasional*, and these don't have the same presupposition. Nevertheless, for *average*, they fail in another respect.

The denotation of *three* is as in (58a), a property of individuals that have a cardinality of 3:

(58)   a. $[\![\, three \,]\!] = \lambda x[|x| = 3]$
         b. $[\![\, three \ \text{BE} \ x_1^k \,]\!] = \lambda y[x_1^k = y \wedge |y| = 3]$

Combining with the shifted denotation of the kind trace, the result is as in (58b). Because the kind corresponding to x_1^k is identical to y and y has a cardinality of 3, it has to be the case that x_1^k has a cardinality of 3. But x_1^k is a kind, not an ordinary individual. Kinds don't have cardinalities, and English number terms can't be predicated of them – hence the ungrammaticality of e.g. *three cheese*. So in this case, the problem that rules out weak quantifiers has to do with kinds, and it will be only nonlocal adjectives that leave behind kind-denoting traces that will be subject to this additional restriction.

Occasional is also incompatible with weak quantifiers, and, as Gehrke and McNally (2010, 2015) demonstrate, its semantics also relies crucially on kinds. Nonlocal adjective with no kind overtones such as *whole* or *wrong* or *unspecified* should therefore avoid running afoul of this difficulty and be compatible with weak quantifiers even on their external readings. And indeed they are.

4.5. Summary

The result, then, is that there is no need for incorporation. The external scope facts follow from QR. The interpretation of determiners is standard. Restrictions on determiners follow from independent considerations. The general resistance of nonlocal adjectives to strong quantifiers follows from the compositional circumstances of their movement, which invoke a type shift with which they are incompatible. The resistance of certain nonlocal adjectives to weak quantifiers follows from independent facts about the lexical semantics of the adjective – specifically, having a kind-based semantics. Other restrictions, like the lack of coordination with ordinary adjectives and absence of degree modifiers, follow from the quantifier type of these expressions.

This means it was not necessary to stipulate which determiners support incorporation and which don't, or what interpretations result for every combination. Nor was it necessary to stipulate why *the*, *a*, and *your* wind up identical, or to do so repeatedly for each frequency adjective. It also wasn't necessary to stipulate anything about the interaction of quantificational force with external readings. This is possible in part precisely because what I have offered here is only a sketch. The devil, as always, is in the details. But I hope this illustrates an analytical approach to these facts that might scale up.

5. Final remark

I'll close with a few words about the analytical intuition – vague and hard to pin down but nevertheless clear and common – that nonlocal readings are a grammatical oddity, a locus of idiosyncrasy.

These adjectives are indeed odd, but in a precise and interesting sense. They are odd in the way that platypuses and lungfish are odd: they are transitional forms in an evolutionary progression, unusual because they combine features of two distinct categories that we normally regard as mutually exclusive. Over succeeding generations of speakers, certain adjectives may emerge from the swampy depths of the inner NP to which they are usually confined, and tentatively make their way onto the dry land of the determiner domain. They can't be expected to make this leap in a single stride, so we can observe them in the midst of their evolutionary journey and thereby discover more about both their origin and their destination. Like platypuses and lungfish, they are important and analytically revealing not despite their strangeness, but because of it.

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Deriving the temporal properties of future markers from aspect[1]

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Abstract. Languages vary in whether or not their future markers are compatible with non-future modal readings (Tonhauser, 2011b). The present paper proposes that this variation is determined by the aspectual architecture of a given language, more precisely *if* and *how* aspects can be stacked. Building on recent accounts of the temporal interpretation of modals (Matthewson, 2012, 2013; Kratzer, 2012; Chen et al., ta), the paper first sketches an analysis of the temporal readings of the English future marker *will* and then provides cross–linguistic comparison with a selected, typologically diverse set of languages (Medumba, Hausa, Gitksan, and Greek).

Keywords: Future, Aspect, Cross–linguistic variation

1. Introduction

Cross–linguistic research suggests that future markers differ in whether they can receive non–future readings (for discussion see Tonhauser 2011b). There seems to be one class of languages whose future markers entail future–shifting in all their occurrences. This class includes Paraguayan Guaraní (Tonhauser, 2011b), Gitskan (Matthewson, 2012, 2013) and Hausa (Mucha, 2012, 2013). Hence, the future morphemes in these languages are incompatible with non–future modal interpretations such as present–oriented epistemic necessity. This is illustrated for the Guaraní future marker *–ta* in (1), for the Gitksan future marker *dim* in (2) and for the Hausa future marker *zā* in (3).[2]

(1) Context: I try to soothe my friend whose child hasn't come home from school yet.

   # Oi-mé-**ta**   iñ-angirû-ndive.   (Paraguayan Guaraní, Tonhauser 2011b)
   A3-be-FUT B3-friend-with
   Intended: "He'll be with his friend."

(2) Context: You hear pattering on the roof.

   # yugw=imaa/ima'=hl **dim** wis   (Gitksan, Matthewson 2013)
   IMPF-EPIS=CN   FUT rain
   Intended: "It might be raining."

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[2]The data from Hausa and Medumba stem from the author's own fieldwork, and the following glosses are used: PERF = perfect, PFV = perfective, IPFV = imperfective, PROG = progressive, PROSP = prospective, PRES = present, PST = past.

(3)   Context question: Why are Ibrahim and Bello not at home?

      # **Zā** sù   wurin aikì̀ yanzù   (Hausa, Mucha 2013)
      FUT 3PL.PROSP PREP work now
      Intended: "They will/must be at work right now."

Languages of the second class, including many Indo–European languages, differ from Guaraní, Gitksan and Hausa in that their future markers are compatible with non–future interpretations. This is illustrated for Greek, English[3] and Medumba in (4), (5) and (6), respectively.

(4)   I   Ariadne **tha** troi   tora   (Greek, Giannakidou and Mari 2014)
      the Ariadne FUT eat.ipfv.non–pst.3sg now
      "Ariadne must be eating now."

(5)   Context: Your sister is visiting, but your daughter Alex is staying in her room. Your sister asks you why, but you can only guess:

      Alex **will** be busy.   (English)

(6)   Context: You want to visit your friend Elodie. When you arrive at her house, you see that the lights are on, so you say:

      Elodie **á'** mbʉ cum ntu' ndá   (Medumba, Mucha 2015)
      Elodie FUT be   in   piece house
      "Elodie will/must be in her room."

The main claim of this paper is that the cross–linguistic variation observed in the temporal interpretation of future markers is due to differences in the aspectual architecture of the respective languages. This approach is crucially inspired by recent work on the interpretation of modals, in particular Matthewson (2012, 2013), Kratzer (2012) and Chen et al. (ta), and it works on the assumption that future interpretation in natural language involves the meaning components of quantification over possible worlds (modality) and (prospective) futur–shifting (see e.g. Copley 2002, 2009; Rullmann et al. 2008; Tonhauser 2011b). Specifically, I propose that the relevant parameters of variation are i) whether a language overtly realizes the modal or the time-shifting component of future meaning (or both) and ii) if and how aspects can be stacked in a particular language.

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[3]I thank Joseph DeVeaugh–Geiss for his judgments on English.

2. The case of English

2.1. Background assumptions

The existing literature on the English future forms is extensive, and I will not review it in detail here.[4] Most importantly for present purposes, many accounts attribute some modal meaning component to the English future marker *will* (e.g. Enç 1996; Copley 2002, 2009; Klecha 2014); others argue that its meaning is purely temporal (e.g. Kissine 2008; Salkie 2010). As stated in the introduction, I will follow the first approach. I want to argue that the temporal behavior of *will* can be derived from the distribution of aspect if we accept the assumptions in (7).

(7)   a.   The meaning of the future (*will* in English) is modal.

      b.   In English, progressive and perfect aspect are projected in distinct aspect layers (Radford 1997; Hohaus 2013; Beck and von Stechow 2014). In $AspP_1$, the progressive is in complementary distribution with a covert perfective. In $AspP_2$ the perfect is in complementary distribution with a covert prospective.

      c.   The covert prospective must be licensed by a modal element; the default licenser for the covert prospective is *will*. Therefore, *will* always selects for $AspP_2$.

      d.   The perfective aspect requires the time of an event to be included in a contextual reference time[5] (Klein, 1994; Kratzer, 1998). For stative predicates, it only requires temporal overlap. This idea is formalized in the lexical entries for perfective aspect in (7d-i) and (7d-ii), which result in different temporal specifications depending on the eventuality type of the VP predicate.[6]

         i. $[\![\text{PFV}]\!]^{g,c} = \lambda P_{\langle l, \langle s,t \rangle \rangle}.\lambda w.\lambda t.\exists e\ [\tau(e) \subseteq t\ \&\ P(e)(w)]$ if P is eventive

         ii. $[\![\text{PFV}]\!]^{g,c} = \lambda P_{\langle l, \langle s,t \rangle \rangle}.\lambda t.\lambda w.\exists e\ [\tau(e)\ \text{O}\ t\ \&\ P(e)(w)]$ if P is stative

        The reason is that states do not have a well–defined end or beginning and therefore cannot be claimed to be temporally included in a (reference) time interval or to be temporally bounded. Altshuler and Schwarzschild (2013) formulate the idea of temporal unboundedness of stative predicates as in (7e):

      e.   The Temporal Profile of Statives   (Altshuler and Schwarzschild, 2013: p.45)
        For any tenseless stative clause ϕ, if ϕ is true at a moment m, then there is a moment

---

[4]Also, I will not consider the *be going to* future. For comparison and analysis see Copley (2002, 2009).

[5]I occasionally use the abbreviations RT, UT and ET for *reference time*, *utterance time* and *eventuality time*.

[6]This proposal is inspired by Condoravdi (2002)'s AT relation which is cited in (1).

(1)   AT(t,w,P) =

     a. $\exists e\ [\tau(e)(w) \subseteq t\ \&\ P(e)(w)]$ if P is eventive

     b. $\exists e\ [\tau(e)(w)\ \text{O}\ t\ \&\ P(e)(w)]$ if P is stative

     c.   P(w)(t) if P is temporal

m' preceding *m* at which ϕ is true and there is a moment *m'* [sic] following *m* at which ϕ is true.

The present analysis suggests that variation in (7b) and (7c), rather than lexical variation in the meaning of future markers, is the source of the different temporal behavior of future markers across languages. The semantics of the remaining aspect morphemes as well as the (purely modal) semantics of *will* that I am assuming are given in (8).

(8)   a. $[\![\text{IPFV/PROG}]\!]^{g,c} = \lambda P_{\langle l,\langle s,t\rangle\rangle}.\lambda t.\lambda w.\exists e\ [\tau(e) \supseteq t\ \&\ P(e)(w)]^{7}$ (Kratzer, 1998)

      b. $[\![\emptyset\text{--PROSP}]\!]^{g,c} = \lambda P_{\langle i,\langle s,t\rangle\rangle}.\lambda t.\lambda w.\exists t'\ [t' > t\ \&\ P(t')(w)]^{8}$

      c. $[\![\text{PERF}]\!]^{g,c} = \lambda P_{\langle i,\langle s,t\rangle\rangle}.\lambda t.\lambda w.\exists t'\ [t' < t\ \&\ P(t')(w)]$

      d. $[\![\text{will}]\!]^{g,c} = \lambda P_{\langle i,\langle s,t\rangle\rangle}.\lambda t.\lambda w.\forall w'[w' \in \text{BEST}_{O_{(w),(t)}}\ (\text{MB}(w)(t)) \to P(t)(w')]$

2.2. Analysis

The English future marker *will* is compatible with non–future epistemic interpretations. However, only state predicates (9a) and events with progressive aspect marking (9b) allow for these readings, in opposition to bare event predicates (9c).

(9)   Context: Your sister is coming to your house to visit. Your daughter Alex is staying in her room and your sister asks you why, but you can only guess:

      a.   Alex will be busy. (state)

      b.   Alex will be working. (event marked for progressive)

      c.   # Alex will work. (unmarked event, only future reading)

It has also been observed that ongoing present readings cannot be obtained with simple present sentences in English; they require progressive aspect marking as illustrated in (10).

(10)   Context: Your sister asks you what your daughter is doing at the moment. You say:

      a.   She is reading a book.

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[7]I am setting aside any modal meaning components of the progressive. For detailed modal analyses of the progressive in English see Dowty (1977), Landman (1992), and Portner (1998).

[8]A reviewer pointed out to me that I might actually have to assume weak posteriority ($\leq$) rather than strong posteriority ($<$) for the English prospective in order for the analysis to go through, since otherwise it makes wrong predictions for sentences that contain temporal adverbials. I concede that the interaction of aspect and temporal adverbials does not receive much attention here and leave the question of whether the English prospective should be defined involving weak posteriority for future research.

   b.   # She reads a book.

This kind of observation has led some scholars to assume a covert perfective aspect in the grammar of English (see e.g. Arregui 2007; Wurmbrand 2014). The semantic perfective in (10b) would require the reference time of the sentence to include the run time of the reading event. This is not possible since in a present tense sentence the utterance time serves as reference time (cf. Reichenbach 1947), but the utterance time is instantaneous and cannot include a durative event like *reading a book*. This generalization, which is referred to as the *Bounded Event Constraint* by Smith (2008), accounts for the infelicity of (10b) under the assumption of a covert perfective aspect operator.[9]

Moreover, the contrast in (11) shows that also in future contexts, progressive marking is necessary if the context specifies that the reference time is punctual. This, I would like to argue, indicates that also future sentences like (11b) contain a covert perfective aspect.

(11)   Context question: Can I meet Alex tomorrow at 6 p.m. sharp?
   a.   No, Alex will be working.
   b.   # No, Alex will work.

The obligatory future meaning of *will* with eventive predicates as well as the contrast in (11) follow compositionally if we assume the structure in (12) for future progressives like (9b) and (13) for plain future sentences like (9c):

(12)

```
                TP
           ┌────┴────┐
           T        ModP
         ┌─┴─┐    ┌───┴────┐
        t6  PRES will    AspP₂
                      ┌────┴────┐
                   ∅−PROSP    AspP₁
                           ┌────┴────┐
                         PROG       VP
                                 ┌───┴───┐
                                 Alex work
```

(13)

```
                TP
           ┌────┴────┐
           T        ModP
         ┌─┴─┐    ┌───┴────┐
        t6  PRES will    AspP₂
                      ┌────┴────┐
                   ∅−PROSP    AspP₁
                           ┌────┴────┐
                        ∅−PFV        VP
                                 ┌───┴───┐
                                 Alex work
```
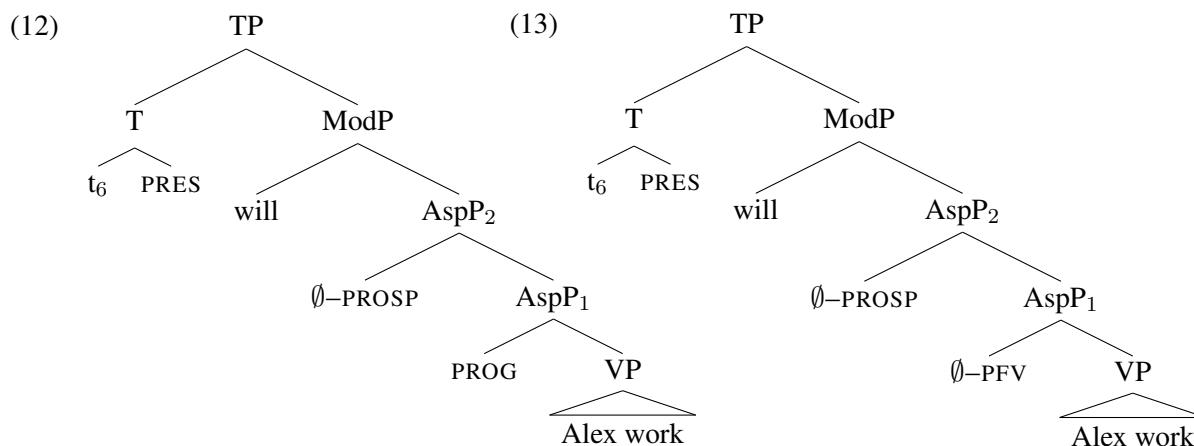
Assuming the semantics for perfective, prospective and *will* that were specified in (7d-i) and (8), we arrive at the truth conditions in (14) for the LF in (13).

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[9] See also Smith et al. (2007) and Smith and Erbaugh (2005) for manifestations of this constraint in Navajo and Mandarin Chinese, as well as Bennett and Partee (1978) and Kamp and Reyle (1993) for similar ideas.

(14) $[[(9c)/(13)]]^{g,c}$ is only defined if g(6) is t_c. If defined:
= λw.$\forall$w' [w' $\in$ BEST$_{O_{(w)(g(6))}}$(MB(w)(g(6))) $\rightarrow$ $\exists$**t'** [**t'** > **g(6) &** $\exists$**e** [τ**(e)** $\subseteq$ **t'** & work(e)(w')
& agent(e)(w') = Alex]]]

The truth conditions in (14) require that there be a future time that includes the running time of the event of Alex working, which is incompatible with a present construal. In the LF in (12), the only difference is that AspP$_1$ hosts a progressive aspect instead of a perfective, while AspP$_2$ is still specified for prospective. The truth conditions then come out as in (15).

(15) $[[(9b)/(12)]]^{g,c}$ is only defined if g(6) is t_c. If defined:
= λw.$\forall$w' [w' $\in$ BEST$_{O_{(w)(g(6))}}$(MB(w)(g(6))) $\rightarrow$ $\exists$**t'** [**t'** > **g(6) &** $\exists$**e** [τ**(e)** $\supseteq$ **t'** & work(e)(w')
& agent(e)(w') = Alex]]]

The truth conditions specified in (15) only require that there be a time after the present RT (i.e. the utterance time t_c) which is included in the time of Alex working. Given that this time interval can be an instant that is located right after t_c, (15) is compatible with the ET including *both* the utterance time and the time introduced by the prospective aspect operator. Thus, the observed under–specification between present and future readings of sentences like (9b) is predicted.

If we accept the assumption made in (7c), the perfective/progressive contrast does not apply to stative predicates in the same way it does to events, since for states the relevant temporal relation between ET and RT is overlap rather than inclusion. Hence, it is predicted that stative predicates pattern with progressive events in allowing for present epistemic readings. For the sake of completeness, the truth conditions of the stative sentence in (9a) are provided in (16).

(16) $[[(9a)]]^{g,c}$ is only defined if g(6) is t_c. If defined:
= λw.$\forall$w' [w' $\in$ BEST$_{O_{(w)(g(6))}}$(MB(w)(g(6))) $\rightarrow$ $\exists$**t'** [**t'** > **g(6) &** $\exists$**e** [τ**(e) O t'** & busy(e)(w')
& agent(e)(w') = Alex]]]

Again, the temporal component of these truth conditions only requires that the time where Alex is busy overlaps the time introduced by the prospective and if we assume with Altshuler and Schwarzschild (2013) that stative eventualities are inherently (temporally) unbounded, there will always be a part of the state of Alex being busy that temporally overlaps a time interval after the reference time g(6) (which in the above case coincides with the utterance time).

Under this kind of approach, past–oriented modal interpretations in English arise if AspP$_2$ is specified for perfect rather than prospective and if AspP$_1$ has a covert perfective aspect, e.g. in the eventive sentence in (17) which gets the LF structure in (18) and the truth conditions in (19).

(17)   Context: Your sister is coming to your house to visit. When she sees your daughter, she remarks that her eyes look red and swollen and she wants to know what happened, you suppose:

   Alex will have cried.

(18)
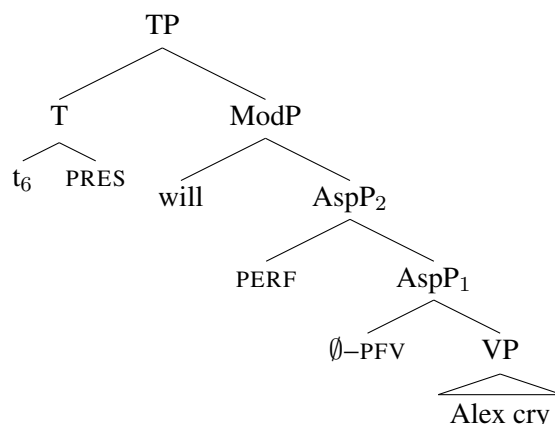
(19) $[\![TP]\!]^{g,c}$ is only defined if g(6) is t_c. If defined:
= λw.$\forall$w' [w' $\in$ BEST$_{O_{(w)(g(6))}}$(MB(w)(g(6)))) $\rightarrow$ $\exists$**t'** [**t' < g(6)** & $\exists$**e** [τ(**e**) $\subseteq$ **t'** & cry(e)(w') & agent(e)(w') = Alex]

These truth conditions correctly predict that in all possible worlds in the modal base there is a time before the reference time that includes an event of Alex crying. As it stands, however, the proposed analysis does not predict the second reading of (18), namely the "past in the future" interpretation (UT < ET < RT, cf. Reichenbach 1947: p.290) where the RT is in the future, and the perfect aspect induces a past shift of the ET relative to this future RT. This reading will be a problem for any account that assumes a Reichenbachian distinction between ET, RT and UT, and also assumes that futur–shifting is aspectual, since the future and the perfect would impose contradictory requirements on the relation between ET and RT. One possible way of solving this is to adopt the proposal of Sauerland (2002) that present tense in English is semantically vacuous. This would remove the presupposition from the truth conditions above, thus allowing that the context shifts the RT to the future. [10]

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[10]Sauerland's proposal of vacuous present tense is not uncontroversial (for a counterargument see Thomas 2015). However, what Sauerland (2002) argues against is the present tense in English carrying a non–past presupposition, a proposal he attributes to Abusch (1997). Even if we assumed a lexical entry of the English present tense which involves a non–past presupposition, the future perfect reading could be derived, since a future RT would be possible. Hence, either of the present tense semantics in (1) would work for the account presented here.

(1)   Present tense in English

   a. $[\![PRES]\!]^{g,c} = \lambda$t. t   (no presupposition)

   b. $[\![PRES]\!]^{g,c} = \lambda$t : $\neg$(t < t_c). t   (non–past presupposition)

Let me summarize the core properties of future interpretation in English. I propose that *will* is a modal future marker that always co–occurs with i) a covert prospective or an overt perfect operator and ii) a covert perfective or an overt progressive operator. The future–shifting component that is associated with *will* comes from the covert prospective. However, if the covert prospective co–occurs with a stative predicate or an event predicate marked for progressive, this results in truth conditions that are compatible with a present epistemic interpretation. Being covert and compositionally optional (i.e. of a modifier type $\langle\langle i, \langle s, t\rangle\rangle, \langle i, \langle s, t\rangle\rangle\rangle$), the covert prospective has to be licensed. In English, the licensing condition is modality. Hence, the covert prospective also occurs with other modal elements such as *can, must* etc. (see Kratzer 2012).

3. Cross–linguistic variation

What I hope to have shown in the last section is that an aspect–based analysis of the temporal readings of English *will* is viable. This section provides a sketch of how the proposed analysis accounts for future interpretation in selected other languages. The proposal for English builds on the analysis of future interpretation in Medumba developed in Mucha (2015), since future in Medumba patterns with future in English in many important respects. Hence, Medumba is the language to be considered first.

3.1. The parallel case: Medumba

Future in Medumba[11] is most commonly marked by the preverbal morpheme *á'*. Moreover, in simple question–answer pairs such as (20), *á'* seems to be necessary for future interpretation.

(20)   Context question: What will Nana and Serge do tomorrow?

    a.   Bu **á'**   ná   ŋkwún (nəmndjʉ)
        they FUT cook beans   tomorrow
        "They will cook beans tomorrow."

    b.   # Bu   ná   ŋkwún (nəmndjʉ)
         they cook beans   tomorrow
         Intended: "They will cook beans tomorrow."

However, future interpretation is licensed without the *á'*–marker in a number of environments which seem to share the property of nonveridicality.[12] For reasons of space this is illustrated only for questions (21), negation (22), and the scope of modals (23), but it also holds for imperatives and antecedents of conditionals (see Mucha 2015).

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[11]Medumba is a Grassfields Bantu language mainly spoken in Western Cameroon in and around the city of Banganté.

[12]For a discussion of nonverdicality in prospective environments see Giannakidou (2014).

(21)   Context: This year Mary is always cooking rice.

   Wú kwádə mbə á   ná   kə   ŋgo mu'?
   you think   that she cook what year other
   "What do you think she will cook next year?"

(22)   Context: Marie has had a very hard time lately. She worked a lot and did not sleep very
       much. How will she be doing when I visit her tomorrow?

   Marie kə̀   mbʉ məbwô
   Marie NEG be   good
   "Marie will not be well."

(23)   Context (adapted from Tonhauser 2011a): A farmer is looking at the clouds; he says:

   mu'djʉ mbəŋ ndú
   maybe rain   fall
   "It might rain."

Not only is the future marker *á'* not necessary for future interpretation in all cases, *á'* does also
not entail future interpretation, as example (6) in the introduction demonstrates for a sentence
with a stative predicate. The contrast in (24) shows that Medumba also patterns with English in
that present–oriented interpretation with *á'* is possible with eventive predicates only if these are
marked for imperfective/progressive aspect (24a), but not in the aspectually unmarked case (24b).

(24)   Context: Roger is coming home from work and is surprised that he does not find his
       children playing in front of the house. Then he realizes that his spouse is already preparing
       dinner, so he can guess what the kids are doing:

   a. Bú **á'** kə́   widə má   yúb
       they FUT IPFV help mother their
       "They will be helping their mother."

   b. # Bú **á'** widə má   yúb
         they FUT help mother their
         Intended: "They will be helping their mother."
         Speaker comment: "This sounds like an order."

Medumba is a graded tense language, i.e. it has temporal morphemes that are specified for remote-
ness. While future interpretation marked by (plain) *á'* is unspecified for remoteness, *á'* can be
combined with additional morphemes, e.g. *cág* in (25a) and *zí* in (25b), to make more fine–grained
temporal distinctions.[13]

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[13]See Mucha (2015) for evidence for the remoteness specifications of *á' cág* and *á' zí* as well as for the under-
specification of plain *á'*. For reasons of space, the present paper also does not discuss the ambiguity of the temporal
markers *cág* and *zí* proposed in Mucha (2015).

(25)   a. Louise **á' cág** nɛ́n ntɑn
            Louise FUT   go market
            "Louise will go to the market (tomorrow)."

        b. Louise **á' zí** nɛ́n ntɑn
            Louise FUT go market
            "Louise will go to the market (in the distant future)."

Finally, Medumba has graded past morphemes as well, which are analyzed as past–shifting opera-
tors in Mucha (2015). However, these graded past morphemes cannot combine with the future
marker *á'* to express past–oriented modality (in the sense of Condoravdi 2002), which requires an
embedding structure. In other words, Medumba does not allow for the equivalent of *will* + perfect
(cf. (17)) in English. This is illustrated with the near past morpheme *fə* in (26).

(26)   Context: Marie participated in a race yesterday. Today she looks very happy, so you
        suspect:

        a. * Marie **á'**   **fə**   cá
            Marie FUT NEAR win
            Intended: "Marie will/must have won."

        b. a **á'** mbʉ zə Marie **fə**   cá
            it FUT be   that Marie NEAR win
            "Marie must have won."
            lit. "It will be that Marie has won."

From the data presented above I would like to conclude the following: Future–shifting in Medumba
is realized either by overt graded future shifters such as *cág* and *zí* or by a covert future shifter
whose meaning parallels that of the English covert prospective proposed in (8b) in section 2. Like
in English, this covert future shifter has to be licensed, but in Medumba the licensing condition is
nonveridicality rather than modality.[14] The default licenser for the covert future shifter in Medumba
is *á'*, its meaning parallels that of English *will*. In contrast to *will*, *á'* always selects for a future–
shifting element and cannot combine with a past–shifter. Just like English *will*, however, *á'* is
compatible with present–oriented epistemic readings if it co–occurs with the (covert) indefinite
future shifter and a stative or imperfective predicate.

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[14]Note that, in contrast to the Medumba cases, questions and negation do not generally license future interpretation
in English, while modals do, as illustrated in (1). (Note that the English consultant who provided these judgments
reports that the example in (1a) improves with a specific intonation that possibly indicates contrasting.)

(1)   Future licensing in English

       a. ?? What do you think Mary cooks tomorrow?
       b.   # Mary does not feel well tomorrow.
       c. Tina might win tomorrow.

3.2. Overtly restricted co–occurrence in Hausa

Recall from the introduction (example (3)) that Hausa[15] differs from languages such as English and Medumba in that its future marker *zā* is incompatible with present–oriented epistemic interpretations. In Hausa, TAM forms are usually marked directly on a weak subject pronoun (wsp), but the future marker *zā* diverges from this pattern in that it precedes the wsp. Interestingly, *zā* invariably co–occurs with a low tone on the wsp (27a) which is referred to as a "neutral" or subjunctive marker in the pertinent reference grammars (Newman, 2000; Jaggar, 2001). *Zā* cannot combine with imperfective (27b) or perfective marking (27c).

(27)   a.   **Zā tà**   wàsā gòbe.
            ZĀ 3SG.F-PROSP play tomorrow
            "She will play tomorrow."

       b.   * **Zā ta-nà̀**   wàsā gòbe.
            ZĀ 3SG.F-IPFV play tomorrow
            Intended: "She will be playing tomorrow."

       c.   * **Zā tā**   yi wàsā gòbe.
            ZĀ 3SG.F.PFV do play tomorrow
            Intended: "She will have played tomorrow."

In Mucha (2013), I propose that Hausa is a genuinely tenseless language which marks aspect overtly and obligatorily. Following ideas of Schuh (2003), the neutral/subjunctive form is reanalyzed as a prospective aspect, which must be licensed by a modal operator (like the prospective in English). *Zā* is a modal operator that is lexically specified to license the prospective in the absence of other modals. The crucial difference between Hausa on the one hand, and English and Medumba on the other, is that Hausa does not allow for aspect stacking. As a consequence of this, the Hausa prospective aspect never combines with an imperfective but always directly modifies (i.e. forward–shifts) the ET of a sentence relative to its RT. Epistemic readings as a secondary effect of the combination of prospective and stative/imperfective meaning are therefore not possible in Hausa. Finally, since *zā* always combines with the prospective, it entails future–shifting in all its occurrences.

3.3. Overt realization of prospective aspect in Gitksan

Gitksan (Tsimshianic), like Hausa, has an overt prospective aspect marker, the morpheme *dim*. Matthewson (2012, 2013) shows that *dim* overtly contributes the future orientation of modals in

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[15]Hausa is a Chadic language mainly spoken in Northern Nigeria.

Gitksan. Modals that are lexically specified for circumstantial flavor[16] always co–occur with *dim*, which invariably makes them future–oriented. Epistemic modals, by contrast, can occur without the prospective marker, but in this case only allow for non–future orientation. With *dim* their interpretation is invariably future–oriented. The contrast is illustrated in (28) from Matthewson (2013) (contexts omitted).

(28) a. yugw=imaa/ima’=hl wis
          IMPF=EPIS=CN   rain
          "It might have rained." / "It might be raining." / $\neq$ "It might rain (in the future)."

      b. yugw=imaa/ima’=hl **dim** wis
          IMPF=EPIS=CN   FUT rain
          $\neq$ "It might have rained." / $\neq$ "It might be raining." / "It might rain (in the future)."

With respect to the analysis of the future that I have been arguing for, we might expect future in Gitksan to be realized in a similar way as it is in Hausa, i.e. the modal and the temporal components of future interpretation are both overtly encoded. However, according to Matthewson (2012, 2013), *dim* is both necessary and sufficient for future interpretation, as shown in (29).

(29)   * **(dim)** limx=t   James t’aahlakw   (Matthewson, 2013)
             FUT   sing=DM James tomorrow
             "James will sing tomorrow."

Transferring this to the discussion on English, Hausa and Medumba above, it seems that in Gitksan the prospective does not have to be licensed by a modal or a nonveridical operator. This might not even be surprising in a language that overtly realizes future orientation, although it contrasts with the observation that in Hausa the overt prospective must be licensed. Moreover, taking the data from Gitksan at face value suggests that future interpretation does not (or not necessarily) involve modality after all. There is a caveat, however. According to Matthewson (2013), *dim* is not only used for plain predictive future sentences, but also for expressing other kinds of modality, e.g deontic necessity as in (30).

(30)   Context: I tell you that Bob stole a book from the store.
       dim ap   guuxws ma<u>k</u>-d-i-s   Bob   (Matthewson, 2013)
       FUT EMPH back   give-T-TRA-PN Bob
       "He has to give it back."

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[16]According to Matthewson (2013), modals in Gitksan are lexically specified for their conversational background. Quantificational force is specified for circumstantial, but not for epistemic modals.

Matthewson (2013) mentions two possible explanations for this range of interpretations of sentences with (plain) *dim*. Either examples like (30) are in fact plain future statements and the modal interpretations arise via inferences, or there is a covert modal element occurring in plain *dim*–sentences. If we adopted the latter assumption, Gitksan would be the complementary case of English and Medumba in that the temporal component of the future is realized overtly while the modal one is covert.

Recall also that I propose to account for the possibility of present–oriented epistemic interpretations of future markers by reference to the aspectual architecture of a given language. More concretely, the proposal is that in English, Medumba and Hausa future marking always comes with a modal and a temporal component, but that the temporal component is covert in English and Medumba. The fact that only the Hausa future does not allow for present epistemic interpretations is attributed to the fact that Hausa does not allow for aspect stacking so that the prospective can never co–occur with an imperfective marker. The formal analysis of Gitksan modal sentences with *dim* provided in Matthewson (2012) suggests that it not only matters *if* a language marks grammatical aspect and if aspect can be stacked, but also *how* aspects can be stacked. Matthewson (2012) reports that, like English and Medumba, Gitksan allows for overt co–occurrence of prospective and imperfective aspect. Therefore, both aspects are formalized as quantifiers over times with an $\langle\langle i,\langle s,t\rangle\rangle,\langle i,\langle s,t\rangle\rangle\rangle$ modifier type (like the meaning that I proposed for the future shifters of English and Medumba). Existential quantification over the event variable is encoded in a bleached aspect head (31a). The lexical entries of the prospective marker *dim* and the imperfective morpheme *yukw*, cited from Matthewson (2012: p.438), are given in (31b) and (31c).

(31) a. $[[\text{ASP}]] = \lambda P_{\langle ev,st\rangle} \; \lambda t \; \lambda w. \; \exists e \; [P(e)(w) \; \& \; \tau(e) = t]$

b. $[[dim]] = \lambda P \in D_{\langle i,st\rangle} \; \lambda t \; \lambda w. \; \exists t' \; [t < t' \; \& \; P(t')(w) = 1]$

c. $[[yukw]] = \lambda P \in D_{\langle i,st\rangle} \; \lambda t \; \lambda w. \; \exists t' \; [t' \supseteq t \; \& \; P(t')(w) = 1]$

Given what I proposed earlier, I would expect that the combination of prospective and imperfective in Gitksan is compatible with a present epistemic interpretation, which does not seem to be the case, as illustrated in example (28b) above. However, the truth conditions that Matthewson (2012) gives for a prospective imperfective sentence (with epistemic modality) suggest that in Gitksan it is the prospective aspect that attaches to the VP (more precisely to $[[\text{ASP}]]([[\text{VP}]])$). Hence the prospective aspect shifts the ET to the future of the time introduced by the imperfective, which includes the RT. The truth conditions of (28b) are cited in (32).

(32) $[[ima('a)_{\text{MB}} \; yukw \; dim \; \text{asp} \; wis]] = \lambda t \; \lambda w \; \exists w' \; [w' \in \text{MB}(w,t) \; \& \; \exists t' \; [t' \supseteq t \; \& \; \exists t'' \; [t' < t'' \; \&$
$\exists e \; [[\text{it rains}](w')(e) \; \& \; \tau(e) = t'']]]]$ (Matthewson, 2012: p.438)

By contrast with the truth conditions in (32), my proposal for Medumba and English implies that imperfective and (covert) perfective always apply to the VP, and that the prospective has to be

stacked on top, with the effect that the prospective never directly modifies the ET. Therefore, if my interpretation of Matthewson (2012) is correct, the compositional order of prospective and imperfective aspect could explain the difference between Gitksan on the one hand, and English and Medumba on the other hand, even if all of these languages allow for aspect stacking.

3.4. Overt free co–occurrence in Greek

Another language I want to consider, albeit only briefly, is Greek. Modern Greek (and Italian) as described by Giannakidou and Mari (2013a, b, 2014, ta) are among the languages that allow for non–future interpretations with future marking (like English and Medumba). According to Giannakidou and Mari (ta), in Greek the predictive interpretation with the future marker arises in combination with a perfective non–past (PNP) form. This is illustrated in (33).

(33)   O   Janis **tha** ftasi   avrio.   (Giannakidou and Mari, ta)
       the John FUT arrive.PNP.3sg tomorrow
       "John will arrive tomorrow."

Giannakidou (2009) defines the meaning of non–past as denoting an open interval which licenses a future interpretation, but does not force it. The formalization is given in (34).

(34) $[\![\text{nonpast}]\!] = \lambda P \, \lambda t \, P((t, \infty))$ (Giannakidou, 2009)

Giannakidou and Mari also argue that the time variable of the Greek non–past must be interpreted as a bound variable. It must be licensed by a nonveridical particle (see Giannakidou and Mari 2013a: p.257) and one possible licenser is the future particle *tha*. *Tha* licenses the defective non–past by supplying the UT as a RT, i.e. as a left boundary to the open interval denoted by the non–past.

Giannakidou and Mari also report that the Greek future systematically receives epistemic present interpretations when combined with stative predicates (35a) or with imperfective non–past (35b).

(35)   a. I   Ariadne **tha** ine   arrosti   (Giannakidou and Mari, 2014)
          the Ariadne FUT be.3sg sick
          "Ariadne must be sick."
       b. I   Ariadne **tha** troi   tora
          the Ariadne FUT eat.ipfv.non–pst.3sg now
          "Ariadne must be eating now."

In order to get past–oriented epistemic readings, the Greek future particle *tha* can be combined with the perfective past (PP) form, illustrated in (36) (from Giannakidou and Mari 2013a: p.258).

(36) I   Ariadne **tha** kimithike   (orin apo dyo   ores).
      the Ariadne FUT sleep.PP.3sg before two hours
      "Ariadne must have fallen asleep two hours ago."

Hence, Greek fits into the cross–linguistic picture as follows: As Giannakidou and Mari (2014) make explicit, Greek patterns with Gitksan in making the compositionality of future interpretation and prospectivity obvious. Predictive future readings arise in Greek only if the future modal *tha* is combined with perfective non–past, which has the meaning in (34). This perfective non–past, under their analysis, behaves like the Hausa prospective in that it is defective and must be licensed by a modal/nonveridical particle like *tha*. The future modal *tha* differs from the future modals of Hausa, Medumba, and English under my analysis in that it does not obligatorily co–occur with a future–shifter, but the future shifter under *tha* is in complementary distribution with an imperfective non–past and a perfective past.

A concluding conjecture: If the line of reasoning proposed here is on the right track, it can also account for attested variation *within* the class of languages that allow for non–future epistemic interpretations with future modals. As stated by Giannakidou and Mari (2014) and confirmed by English native speakers I consulted, purely epistemic readings with English *will* are much harder to obtain than with its counterparts in Greek and Italian, and *will* seems to have some kind of future flavor in all its uses.[17] Under the present account, this can be related to the assumption that English *will* is always prospective and the present epistemic reading is a secondary effect in the sense that it does not contradict the derived truth conditions, as shown in section 2. In Greek, by contrast, there is no future–shifting at all in a sentence like (35b), which makes a present reading much more natural.

4. Summary

Languages differ with respect to the degree to which future marking is compatible with present readings (see Tonhauser 2011b). This paper proposes to account for this by referring to cross–linguistic differences in the aspectual architecture of languages, assuming that future interpretation generally involves two meaning components: modality and (prospective) future–shifting. Languages may overtly realize the modal component (e.g. English), the temporal component (e.g. Gitksan), or both (e.g. Hausa). If an overt future modal always occurs with a semantic future shifter which is in complementary distribution with other aspects, present readings are excluded. This is the case in Hausa. If a future modal always occurs with a future shifter, but this future shifter can be stacked on top of imperfective aspect, present readings are predicted to be possible

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[17]Besides my colleague Joseph De Veaugh–Geiss, I am grateful for judgments from and discussion with participants of the SIASSI 2015 and of SuB 20. Systematic testing of this generalization is desirable, but left for future research.

but restricted or slightly marked. This is what I propose for English and Medumba (with the difference that English *will* can also be combined with a perfect instead of a prospective). If a future modal freely combines with any temporal/aspectual operator, but if these cannot be stacked, we expect that present interpretations are available and natural with a combination of the future modal and imperfective aspect, but excluded with a combination of the future modal and the prospective or its equivalent. Judging from the data presented by Giannakidou and Mari, this might be the case in Greek. Table 1 provides an overview of the proposed typology developed in this paper.

	English	Medumba	Hausa	Greek	Gitksan
FUT – modal	*will*	*á'*	*zā*	*tha*	covert (?)
Co – occurrence	PERF/ ∅–PROSP + PROG/ ∅–PFV	∅–PROSP + IPFV/ ∅–PFV	PROSP –	PNP/ PST/ INP –	IPFV/ PFV + PROSP
FUT – shifting	covert	covert	PROSP	PNP	*dim*
Readings	fut, pst, (pres)	fut, (pres)	fut	fut, pst, pres	fut
Licensing	modal	nonveridical	modal	nonveridical (?)	–

Table 1: Cross–linguistic variation in future marking

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A contest of strength: *or* versus *either–or*[1]

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Abstract. Many languages have more than one way of conveying disjunction. Often one of these forms seems more strongly associated with an exclusive interpretation than the other. For example, in English *either–or* is felt to be more exclusive than plain *or*, and the same holds for German *entweder–oder* vs plain *oder*. In this paper we demonstrate experimentally that the difference in strength only arises when the two forms are both used; in isolation both disjunctions exhibit the same level of exclusivity. Our theoretical account assumes that only the stronger form is obligatorily associated with an implicature generating exhaustification operator, but given the strongest meaning preference in neutral, non-contrastive, contexts, the exhaustified interpretation is also employed for the weaker form. To account for contrastive contexts, we must furthermore employ the covert epistemic modal from Meyer (2013), and claim that the strong form acts as an alternative to the weak form, thereby generating an implicature that blocks the application of the strongest meaning preference.

Keywords: disjunction, alternatives, scalar implicature, exhaustification.

1. Introduction

Most languages have more than one way of conveying disjunction. In English we find *or* and *either–or*, in German *oder* and *entweder–oder*, in French *ou*, *ou–ou* and *soit–soit*, in Romanian *sau*, *ori*, *ori–ori*, *fie–fie*, and in Hungarian *vagy*, *vagy–vagy* and *akár–akár*. One of the main differences between these ways of conveying disjunction within a language relates to whether the disjunction is interpreted inclusively or exclusively in positive contexts.[2] In example (1), the exclusive inference is that Mary didn't visit both John and Bill. But both the simple disjunction *or* in (1a) and complex disjunction *either–or* in (1b) seem to support the exclusive inference.

(1)   a.   Mary will visit John or Bill. ⤳ *Mary won't visit both.*
         b.   Mary will visit either John or Bill. ⤳ *Mary won't visit both.*

Nevertheless the two disjunctions are intuitively felt to be different as is shown by the fact that logic textbooks in both English and German use the complex disjunction for exclusive

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[2]Nonetheless, in the languages that make a three and even a four-way distinction, it remains to be understood what other levels of variation there are.

disjunction. Why do linguistically naive speakers agree that *either–or* is the natural language counterpart of the logical exclusive disjunction, while *or* is the natural language counterpart of the logical inclusive disjunction? A difference between the two types of disjunctions becomes apparent when we try to cancel the exclusive inference, as shown below:

(2)   a.   Mary will visit John or Bill, *and possibly both*.
       b.   Mary will visit either John or Bill, #*and possibly both*.

The same contrast is observed cross-linguistically. In French, for example, the difference between the disjunctions *ou* and *soit–soit* can be argued to be parallel to the difference noted above from English.[3] Similarly to the contrast between English *or* and *either–or*, *soit–soit* gives rise to the exclusivity inference more robustly than *ou*, as noted by the fact that a continuation which contradicts the scalar inference 'she will go on both days,' is significantly less natural if the complex disjunction *soit–soit* was used.

(3)   a.   Marie ira au cinéma lundi ou mardi. Absolument! Et elle ira même à la fois lundi
             ET mardi.
             'Marie will go to the movies on Monday or Tuesday. Absolutely! She will even
             go both days.'
       b.   Marie ira au cinéma soit lundi soit mardi. #Absolument! Et elle ira même à la fois
             lundi ET mardi.

In (4) we see the same contrast surfacing in German, with *entweder oder* exhibiting the same restriction as *either–or* and *soit–soit*.

(4)   a.   Maria geht nächsten Freitag oder Samstag ins Konzert, und vielleicht an beiden
             Tagen.
             'Mary will go next Friday or Saturday to a concert, and maybe on both days.'
       b.   #Maria geht entweder nächsten Freitag oder Samstag ins Konzert, und vielleicht an
             beiden Tagen.

Differences in the strength of implicatures have recently been shown in other domains by van Tiel et al. (2016) experimentally. But a theoretical understanding of such differences has remained elusive. The difference between *or* and *either–or* provides new insights on this debate. In this paper, we first investigate empirically the difference in implicature strengh in both English and German in section 3. We show that when *or* and *either–or* are compared across subjects no difference arises, but when the two are compared within subjects there is a difference. Our account of these data is presented in Section 4. Before we present our new data, we introduce some theoretical background in the form of an account of implicatures (the grammatical approach), and some discussion of previous work on simple vs complex disjunction.

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[3]The French data is from Spector (2014), unless otherwise noted.

2. Preliminaries

2.1. The grammatical approach to implicatures

In this paper we adopt the view that implicatures are derived in the grammar via a mechanism of exhaustification. The idea is that scalar elements activate alternatives and the grammar integrates these alternatives in a systematic way within the meaning of the utterance. Chierchia, Fox, and Spector (2012) (building on work in Krifka 1995, Chierchia 2004, Spector 2006, Fox 2007, among others) argue that scalar implicatures are the result of a syntactic ambiguity resolution in favor of an LF which contains a covert exhaustivity operator $\mathcal{E}xh$. This operator makes the same contribution as *only*, with the only difference being that $\mathcal{E}xh$ asserts rather than presupposes the truth of its prejacent, as in (5).[4]

(5) $\mathcal{E}xh(p) = p \land \forall q \in \mathcal{A}lt(p))[p \not\subseteq q \to \neg q]$
       (the assertion p is true and any alternative q not entailed by p is false)

Consider the example below, where the relevant alternative is the conjunction.

(6)   John talked to Mary or Bill.
       a. $\mathcal{A}lt$(John talked to Mary or Bill) = {John talked to M or B, John talked to M and B}
       b. $\mathcal{E}xh$[John talked to Mary or Bill] = John talked to Mary or Bill but not both.

In (6), exhaustification proceeds via $\mathcal{E}xh$. $\mathcal{E}xh$ negates all stronger statements which can be obtained from the prejacent by replacement of the scalar element (disjunction) with an alternative (conjunction), thus delivering the enriched meaning in (6b). It is worth noting, however, that a sentence like (6) does not always have the enriched meaning in (6b)—depending on the context, the implicature that 'John didn't talk with both Mary and Bill' may or may not be present. Assuming this grammatical approach to scalar implicatures, there are a few ways to think about the optionality of implicatures. One option is to take exhaustification to be an obligatory operation and appeal to a notion of alternative pruning in order to derive non-enriched meanings (cf. Fox and Katzir 2011 among others). Under this approach the difference between the inclusive and exclusive use of disjunction would be the result of what alternative set $\mathcal{E}xh$ makes reference to: for the inclusive reading the alternative set would be empty, whereas for the exclusive reading the alternative set would be as in (6a). Another option is to assume that the exhaustification operator is itself optional. Under this approach, a sentence like (6) can be said to be ambiguous between the two LFs in (7); note that under this approach the alternative set would remain constant.[5]

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[4]This is a vastly simplified version but it will do for our purposes.

[5]It is worth noting that assuming optional exhaustification is akin to assuming that all distinct alternatives are pruned.

(7)   John talked to Mary or Bill.

         a.   John talked to Mary or Bill   *inclusive*

         b. $\mathcal{E}xh$[John talked to Mary or Bill]   *exclusive*

2.2. Simple versus complex disjunctions

As already discussed above, on the approach we adopt, the scalar implicature 'not both' comes about as the result of applying the $\mathcal{E}xh$ operator, as outlined below:

(8)   a. $\mathcal{E}xh(p \vee q) = (p \vee q) \wedge \neg(p \wedge q)$

         b. $\mathcal{E}xh$[Mary will visit John or Bill] = Mary will visit John or Bill & Mary won't visit John and Bill

How can we account for the intuition that the SI 'not both' associated with *either–or* is stronger than the SI associated with *or*? Spector (2014) claims that *either–or*, but not *or*, triggers obligatory exhaustification. In other words, plain disjunction is ambiguous between the two LFs in (9), whereas complex disjunction is unambiguously interpreted with an $\mathcal{E}xh$ operator; that is, only the LF in (9b) is available with complex disjunction.

(9)   a. $[p \vee q]$ ✓*or*, ✗*either–or*

         b. $\mathcal{E}xh[p \vee q]$ ✓*or*, ✓*either–or*

Spector leaves open though how the ambiguity *or* creates is resolved by speakers when the implicature is not blocked by other semantic content as in the implicature cancellation data in (2). As we mentioned, authors of math and logic textbooks uniformly find a contrast between *or* and *either–or* even though it is unlikely that they all thought about implicature cancellation contexts before deciding to use plain *or* for inclusive disjunction, and *either–or* for exclusive disjunction. To this end, we designed a series of experiments to detect a difference between *or* and *either–or* in examples not involving implicature cancellation.

3. Experiments

3.1. Experiment 1

The data from 80 native-English subjects was included in this experiment. Participants took the experiment online using the web-based Amazon Mechanical Turk platform. The first page included a demographic question, a declaration of their voluntary and confidential participation in the study, as well as a training session consisting of one example in order to ensure they understood the task. Subjects were asked to select "yes" or "no" in response to the question: "Is English your native language?". They were compensated for their participation regardless

of their answer to this question. We excluded subjects who took the experiment multiple times, as well as those who reported their native language as something other than English.

The subjects were shown 28 pairs of sentences and for each pair, they were asked to judge how likely it is that the sentence between quotation marks suggests the sentence in italics. They were instructed to give answers as diverse as necessary to represent their intuition, which they did by clicking on one of seven buttons below the sentences, ranging from "very unlikely" to "very likely". In order to move on to the next item, a selection on the likelihood scale for the current item had to be made first. Each trial was presented separately on its own page. The trials had the format below:

> "Sandy bought a dress or a shirt."
> **suggests**
> *Sandy didn't buy both a dress and a shirt.*
>
> very unlikely ○ ○ ○ ○ ○ ○ ○ very likely

We manipulated one factor, DISJUNCTION TYPE, which corresponds to which type of disjunction was used: *or* versus *either–or*. Each subject saw 28 trials: 14 critical trials and 14 fillers. This experiment had a between-subject design, and the participants were randomly assigned to one of two groups. The critical trials differed, depending on which of two groups the subjects were assigned to. The 14 critical trials in group 1 were of the form "a or b → not both a and b" (see (I)), while the trials in group 2 were of the form "either a or b → not both a and b" (see (II)). The fillers consisted of scalar items (e.g. "some → not all" and "can → doesn't have to"), as well as non-scalar items (e.g. "visit London → travel to Europe"). Distinct randomized lists were created for every subject, with the only constant being that the first two trials in each list were always fillers.

3.1.1. Results

Averaged ratings for the two conditions are given in the table in (10). Each condition had 40 participants. We fit a linear mixed effects model predicting response by condition (disjunction type). The model included random intercepts for participants and items. We found no significant effect of disjunction type ($p = 0.772$, $\beta = -0.103$, SE $= 0.289$, $t = -0.357$). In Figure 1 we present a violin plot for the two different conditions, *or* and *either–or*; this plot is similar to a box plot except that it also shows the kernel probability density of the data at different values.
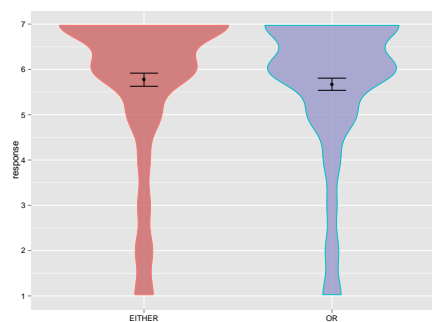
Figure 1: Experiment 1

(10)   *Average response by condition*

	OR	EITHER−OR
Experiment 1	5.671	5.773

3.1.2. Discussion

As discussed above, there is no significant difference between the two conditions, meaning that subjects rated the likelihood of the exclusive inference "not both a and b" as likely for *or* as for *either–or*. The result is consonant with similar findings of a lack of contrast between the simple and complex disjunctions in French and Japanese child language reported by Tieu et al. (2015). But the result is unexpected in light of the discussion in the introduction about the perceived contrast between the two types of disjunctions in terms of the strength of the exclusive inference. There are two main issues that need addressing at this point: (i) how can we reconcile these results with our intuitions, and (ii) how do these results fit in with the theoretical claims we proposed. We postpone the discussion of the first issue for after we have presented the rest of the experiments.

Based on the intuition that *or* is ambiguous between an inclusive and an exclusive interpretation whereas *either–or* unambiguously gives rise to an exclusive interpretation, Spector (2014) proposes an analysis of plain disjunction *or* as ambiguous between the two LFs in (11) while maintaining a non-ambiguous interpretation for the complex disjunction which can only be associated with the LF in (11b). (11b) entails the non-strengthened meaning in (11a).

(11)   a. $[p \lor q]$ $^{\checkmark}$*or*, $^{\times}$*either–or*
           b. $\mathcal{E}xh[p \lor q]$ $^{\checkmark}$*or*, $^{\checkmark}$*either–or*

Prima facie we would expect there to be more variability in the likelihood associated with the exclusive inference for the plain disjunction than for the complex disjunction given the proposed ambiguity. The fact that we do not see such variability and furthermore, that the plain disjunction *or* is as likely as the complex disjunction *either–or* to give rise to the exclusive inference, suggests that subjects strongly prefer the interpretation associated with the LF in (11b) for the plain disjunction. In other words, subjects choose the strongest of the two possible readings associated with *or*. In light of what we know about ambiguity resolution this turns out not to be a surprising finding after all since the general tendency when resolving ambiguities is to choose the strongest interpretation possible barring any contradictions with the context. One solution that immediately suggests itself is that of appealing to a version of the Strongest Meaning Hypothesis (SMH, cf. Heim 1991, Dalrymple et al. 1998, Singh 2011), a pragmatic principle which says that in a sentence with two possible readings, there is a preference for the strongest possible interpretation. We believe that the SMH is indeed implicated in the explanation of our data, but *prima facie*, the SMH would predict that *or* and *either-or* should be equally strong outside of implicature cancellation contexts contrary to our intuitions. Our next experiment tested whether *or* and *either–or* differ when they both occur in the same experiment.

3.2. Experiment 2a

Experiment 2a had a within-subject design. The task and instructions were identical to those in Experiment 1. Unlike in Experiment 1, every participant in this experiment saw the same 14 critical trials, 7 from the *or* condition and 7 from the *either–or* condition, a subset of the trials in Experiment 1, namely (I a-g) and (II a-g). The fillers were the same as before.

3.2.1. Results

The data from 30 subjects was analyzed for this experiment. Averaged ratings for the two conditions are provided in (12). Unlike in Experiment 1, which had a between-subject design, in Experiment 2a which had a within-subject design we found a significant effect of disjunction type ($p < 0.05$, $\beta = -0.291$, SE $= 1.109$, $t = -2.677$), with the *or* condition receiving lower likelihood ratings than the *either–or* condition.
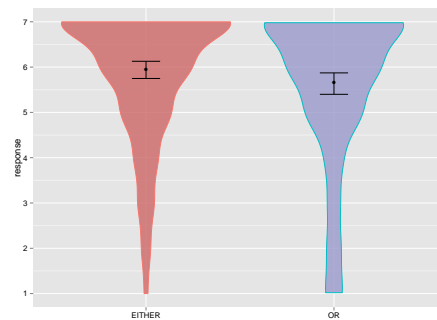
Figure 2: Experiment 2a

(12)   *Average response by condition*

	OR	EITHER−OR
Experiment 1	5.671	5.773
Experiment 2a	5.655	5.946

3.2.2. Discussion

We observe a difference in results once we switch to a within-subject design: ratings for the *or* condition are significantly lower than for the *either–or* condition. One way to interpret these results is as suggesting that subjects are less likely to derive an exclusive inference for *or* sentences than for *either–or* sentences. Given the theoretical foundations introduced above, we could take this to suggest that *or*, otherwise ambiguous between an inclusive and an exclusive interpretation, gets disambiguated in favor of the inclusive interpretation. This raises the question of why there should be a difference in the within-subject experiment but not the between-subject experiment. One may wonder if the difference in ratings between the *or* and *either–or* conditions may be due to the design, namely the fact that the target to filler ratio was one-to-one and thus too small to mask the critical items. If the critical items are not masked well enough, the subjects may adopt a strategy wherein they choose to disambiguate between the two types of disjunctions.

3.3. Experiment 2b

The goal of Experiment 2b was thus to see if additional fillers would affect the results. The task and instructions were identical to those in Experiments 1 and 2a. The only difference is that more fillers were added, bringing the total number to 36. Among the new fillers, 24 of them were of the form "some → not all" and "some but not all → all." When prompted for comments at the end of the task, a few of the participants' comments suggest that they thought the experiment focused on *some/some but not all*, proving that we indeed managed to mask the critical trials more successfully than in the previous experiment.

3.3.1. Results

The data from 40 subjects was analyzed for this experiment. Averaged ratings for the two conditions are provided in the table in (13). As before, we fit a linear mixed effects model predicting response by condition (disjunction type). The model included random intercepts for participants and items. In Experiment 2b, which had a within-subject design similarly to Experiment 2a, we still found a significant effect of disjunction type ($p < 0.05$, $\beta = -0.236$, SE $= 0.094$, $t = -2.505$), with the *or* disjunction receiving lower likelihood ratings than the *either–or* condition.
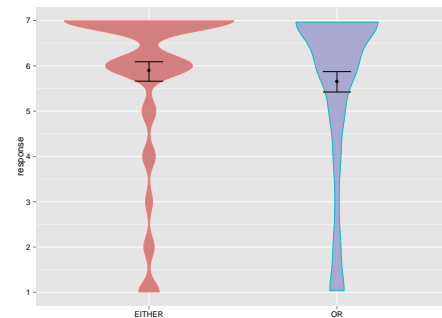
Figure 3: Experiment 2b

(13)   *Average response by condition*

	OR	EITHER−OR
Experiment 1	5.671	5.773
Experiment 2a	5.655	5.946
Experiment 2b	5.657	5.893

3.3.2. Discussion

The results of this experiment indicate once again that when subjects are presented with both types of disjunction, they tend to rate the *either–or* disjunction as more likely to give rise to an exclusive inference than the *or* disjunction. This experiment also shows that an increase in filler items does not affect the results. It is unclear at this point if the participants were actively disambiguating between the two disjunctions or if this "split" happened subconsciously. Nonetheless, it seems fair to conclude that given this task, subjects distinguish between the two conditions.

In the following experiment we probe this result further by changing the task. A possible confound of the current experimental task is that the conjunctive alternative is linguistically provided to the participants. Since our goal is to see if there is a difference between the two types of disjunction in terms of the strength of the exclusive inference, and since this inference comes about by negating, and thus accessing, the corresponding conjunctive alternative, one objection is that participants should not be provided with the alternative linguistically so as not to influence their interpretation.

3.4. Experiment 3

In this experiment we reformulated the task in such a way as to avoid making the conjunctive alternative available linguistically. The participants were shown pairs of sentences and were asked to decide if they could draw the conclusion stated in the second sentence, on a 7-point scale ranging from "not at all" to "yes, definitely." The first sentence was as before, of the form "a or b" or "either a or b", but unlike in the previous experiments, the second sentence was of the form "only one of these . . . ." An example of a critical trial is provided below:

> Jeremy bought a tie or a hat at Target.
> *can you conclude that*
> Jeremy bought only one of these things at Target.
>
> not at all ○ ○ ○ ○ ○ ○ ○ yes, definitely

The experiment consisted of 42 trials, 14 of which were target items and 28 fillers. The critical trials were minimally distinct from those in previous experiments (see (III) and (IV)). The 28 fillers were a subset of those in Experiment 2b, and were changed to reflect the change in the task. As before, distinct randomized lists were created for every subject, with the first two trials in each list being fillers. The subjects were compensated 50 cents for their participation.

3.4.1. Results

In the table below in (14) we report the averaged ratings collected from 36 subjects. A linear mixed effects model predicting response by condition (disjunction type) was fit. The model included random intercepts for participants and items. We found a significant effect of disjunction type ($p < 0.05$, $\beta = -0.274$, SE $= 0.099$, $t = -2.763$), with the conclusion "only one" being ranked lower in the *or* condition than in the *either–or* condition.
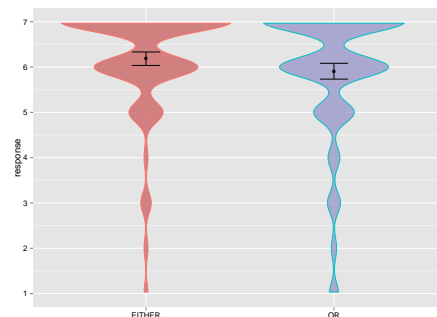
Figure 4: Experiment 3

(14)   *Average response by condition*

	OR	EITHER−OR
Experiment 1	5.671	5.773
Experiment 2a	5.655	5.946
Experiment 2b	5.657	5.893
Experiment 3	5.913	6.187

3.4.2. Discussion

The results of this experiment suggest, once again, that participants distinguish between *or* and *either–or* when asked to rate the likelihood of the exclusive inference. We see that this difference persists even when the conjunctive alternative is not provided linguistically to the participants. This experiment serves to show that even in the absence of an overt conjunctive alternative, subjects still employ this alternative to derive the exclusive inferences, and that just as before, they disambiguate between the two types of disjunctions.

3.5. Experiment 4

The goal of Experiment 4 was to see if the same contrast between plain and complex disjunction surfaces in German. Unlike the previous experiments, this experiment was hosted on Ibex Farm.[6] The first page included a demographic question, a declaration of their voluntary and confidential participation in the study, as well as a training session consisting of one example in order to ensure they understood the task. The entire experiment was in German. Subjects were recruited via mailing lists and were not compensated for their participation.

The subjects were shown 20 pairs of sentences and for each pair, they were asked to judge how likely it is that the sentence between quotation marks suggests the sentence in italics. They were instructed to give answers as diverse as necessary to represent their intuition, which they did by clicking on one of seven buttons below the sentences, ranging from *extrem unwahrscheinlich* "very unlikely" to *extrem wahrscheinlich* "very likely". In order to move on to the next item, a selection on the likelihood scale for the current item had to be made first. The trials had the format below:

> "Sonja has sich ein Kleid oder ein Shirt gekauft."
> **legt nahe:**
> *Sonja hat nicht ein Kleid und ein Shirt gekauft.*
>
> extrem unwahrscheinlich ○ ○ ○ ○ ○ ○ ○ extrem wahrscheinlich

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[6]http://spellout.net/ibexfarm/

We manipulated the same factor as before, DISJUNCTION TYPE, corresponding to which type of disjunction was used: *oder* "or" versus *entweder–oder* "either–or". This experiment had a within-subject design similarly to Experiments 2a, 2b and 3. Each subject saw the same 20 trials: 10 critical trials and 10 fillers. The 10 critical trials were evenly split between the two conditions (see (V) and (VI) for the specific items). The fillers consisted of both scalar and non-scalar items.

3.5.1. Results

In the table below in (15) we report the averaged ratings collected from 33 subjects. We fit a linear mixed effects model predicting response by condition (disjunction type), with random intercepts for participants and items. We found a significant effect of disjunction type ($p < 0.001$, $\beta = -0.479$, SE $= 0.128$, $t = -3.747$), with the *or* disjunction receiving lower likelihood ratings than the *either–or* condition.

Figure 5: Experiment 4

(15)   *Average response by condition*

	OR	EITHER−OR
Experiment 2a	5.655	5.946
Experiment 4	5.230	5.709
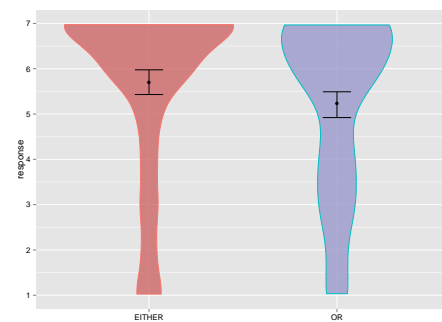
3.5.2. Discussion

The results of this experiment show that German participants exhibit the same difference between simple and complex disjunctions as English participants do.

4. General discussion

The question posed by the results of Experiments 2–4 suggests that subjects ascribe different meanings to the two types of disjunctions. The most straightforward interpretation of these results is to claim that the plain disjunction *or* is disambiguated in favor of its non-exhaustified meaning, namely the inclusive interpretation.

(16)   a.   **LF for *or*:** $p \vee q$
         b.   **LF for *either–or*:** $\mathcal{E}xh[p \vee q]$

This interpretation of the data does not quite capture the observation that this disambiguation is parasitic on the co-occurrence of the two types of disjunctions. In the following we formulate a different proposal that capitalizes on this fact by arguing that what is actually going on is that in a context where both *or* and *either–or* are used to express disjunction, the two disjunctions enter into a competition with each other such that the alternative relevant when computing the meaning of *or* is not *and* but rather *either–or*.

To this end, the first option we may consider is as in (17), where the alternative to *or* is *either–or*, on its interpretation provided in (16b). We retain the claim in Spector (2014) that *either–or* triggers obligatory exhaustification, meaning that *or* will always have as its alternative an already exhausted expression. The problem with this approach is that it amounts to *or* receiving a conjunctive interpretation. This clearly is not the interpretation subjects ascribe to the plain disjunction *or* given the setup of the experiments. Recall that the subjects were asked to judge the likelihood of the exclusive interpretation. If the plain disjunction did in fact receive the meaning in (17b), we would expect the exclusive inference to be rated very low since it is in clear contradiction with the exhaustified meaning of *or*. Our results thus suggest that this is not the appropriate prediction.

(17) $\mathcal{E}xh[p \vee q]$

    a. $\mathcal{A}lt(p \vee q) = \{p \vee q, (p \vee q) \wedge \neg(p \wedge q)\}$

    b. $[\![\mathcal{E}xh[p \vee q]]\!] = (p \vee q) \wedge \neg[(p \vee q) \wedge \neg(p \wedge q)]$
                   $= p \wedge q$

In light of this obstacle, we suggest a different approach which relies on the analysis pursued in Meyer (2013). Meyer argues that uncertainty implicatures (*I don't know which one*) normally thought of as arising via pragmatic principles (e.g. via Grice's Cooperative Principle), can also be derived in the grammar, similarly to scalar implicatures. The claim is that assertively used sentences contain a covert doxastic operator which is adjoined at the matrix level at LF (cf. also Kratzer and Shimoyama (2002), Chierchia (2006) and Alonso-Ovalle and Menéndez-Benito (2010) for similarly minded proposals). Meyer calls this operator **K** following Gazdar (1979) and gives it the semantics in (18). We will represent this operator as a necessity modal throughout the remainder of the text.

(18) $[\![\mathbf{K}_x\, \mathrm{p}]\!] = \lambda w.\forall w' \in \mathrm{Dox}(x)(w) : p(w')$
       $w' \in Dox(x)(w)$ *iff given the beliefs of x in w, w' could be the actual world.*

By bringing this operator into the grammar, the result of exhaustification will vary between what Sauerland (2004) calls primary ($\neg\mathbf{K}p$) and secondary implicatures ($\mathbf{K}\neg p$) implicatures, depending on whether the exhaustification operator scopes above or below the doxastic operator.[7] If $\mathcal{E}xh$ takes widest scope, as in (19), the resulting meaning for *either–or* will be as in

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[7]For the purposes of this presentation we only consider exhaustification with respect to the scalar alternative; this will keep the presentation simpler without actually affecting the end result.

(19b) with a primary implicature, given the alternative in (19a).

(19)   **LF for *either–or*:** $\mathcal{E}xh\mathbf{K}[p \vee q]$

       a. $\mathcal{A}lt(\mathbf{K}[p \vee q]) = \{\mathbf{K}[p \vee q], \mathbf{K}[p \wedge q]\}$

       b. $[\![\mathcal{E}xh\mathbf{K}[p \vee q]]\!] = \mathbf{K}[p \vee q] \wedge \neg\mathbf{K}[p \wedge q]$

Recall our proposal: *or* competes with *either–or*, so the alternative to *or* is the strengthened disjunction, rather than the conjunction. That means that in order to derive the strengthened meaning of *or*, we have to check what happens when exhaustification occurs with respect to the alternative derived in (19b).

(20)   **LF for *or*:** $\mathcal{E}xh\mathbf{K}[p \vee q]$

       a. $\mathcal{A}lt(\mathbf{K}[p \vee q]) = \{\mathbf{K}[p \vee q], \mathcal{E}xh\mathbf{K}[p \vee q]\}$

                         $= \{\mathbf{K}[p \vee q], \mathbf{K}[p \vee q] \wedge \neg\mathbf{K}[p \wedge q]\}$

       b. $[\![\mathcal{E}xh\mathbf{K}[p \vee q]]\!] = \mathbf{K}(p \vee q) \wedge \neg[\mathbf{K}[p \vee q] \wedge \neg\mathbf{K}[p \wedge q]]$

                         $= \mathbf{K}[p \wedge q]$

We see that just as before, we derive a much too strong meaning for the simple disjunction, one that is crucially in conflict with the exclusive inference. Recall that plain *or* is still judged to allow an exclusive inference. We can conclude thus that participants are not interpreting *or* as in (20b), i.e. that the alternative to *or* is not *either–or* on the LF in (19).[8]

Another possible scenario is one where *either–or* is associated with the LF in (21) and receives the interpretation in (21b).

(21)   **LF for *either–or*:** $\mathbf{K}\mathcal{E}xh[p \vee q]$

       a. $\mathcal{A}lt(p \vee q) = \{p \vee q, p \wedge q\}$

       b. $[\![\mathbf{K}\mathcal{E}xh[p \vee q]]\!] = \mathbf{K}[p \vee q] \wedge \mathbf{K}\neg[p \wedge q]$

Given this meaning for *either–or*, let's check what happens when *or* takes as its alternative this stronger meaning under the LF in (22).

(22)   **LF for *or*:** $\mathcal{E}xh\mathbf{K}[p \vee q]$

       a. $\mathcal{A}lt(\mathbf{K}[p \vee q]) = \{\mathbf{K}[p \vee q], \mathbf{K}\mathcal{E}xh[p \vee q]\}$

                         $= \{\mathbf{K}[p \vee q], \mathbf{K}[p \vee q] \wedge \mathbf{K}\neg[p \wedge q]\}$

       b. $[\![\mathcal{E}xh\mathbf{K}[p \vee q]]\!] = \mathbf{K}[p \vee q] \wedge \neg[\mathbf{K}(p \vee q) \wedge \mathbf{K}\neg(p \wedge q)]$

                         $= \mathbf{K}[p \vee q] \wedge \neg\mathbf{K}\neg[p \wedge q]$

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[8]This meaning is probably out for independent reasons, such as the fact that the result of exhaustification gives rise to a meaning that is stronger than the alternative.

This strengthened meaning for *or* is now compatible with the results of our experiments: the meaning associated with *or* is weaker than the meaning associated with *either–or*. Furthermore, this strengthened meaning of *or* is compatible with $\neg\mathbf{K}[p \wedge q]$, explaining why subjects did not rate the exclusive inference on the low end of the scale.

5. Conclusion

We have shown that, out of the blue, plain *or* and *either–or* have the same interpretation and specifically, that the exclusivity inference is equally strong for both. We argued that this comes about due to a general pragmatic principle which dictates that the strongest meaning should be employed when a sentence is ambiguous. Only when the two structures are contrasted within the same experiment does a difference surface between *or* and *either–or*. We showed that the data could be derived if we assume that the meaning of the *either p or q* sentence with its secondary implicature $\mathbf{K}\neg[p \wedge q]$ is available as an alternative for *p or q* when the two are contrasted. Our account makes the prediction that the order of presentation should have an effect on the results such that *or* should be interpreted with the implicature from above only after at least the first occurrence of *either–or*. In future work we plan to investigate this prediction in more detail.

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6. Appendix

6.1. Experiments 1 & 2 critical trials

(I) **Or**

  a. Bill gave Mary flowers or chocolate for her birthday. *suggests* Bill didn't give her both flowers and chocolate.

  b. Mark sent Jon a puzzle or a Gameboy. *suggests* Mark didn't send Jon both a puzzle and a Gameboy.

  c. Sandy bought a dress or a shirt. *suggests* Sandy didn't buy both a dress and a shirt.

  d. Danny met with Laine or Suzy. *suggests* Danny didn't meet with both Laine and Suzy.

  e. Joanne invited David or Sabine to the party. *suggests* Joanne didn't invite both David and Sabine to the party.

  f. Tia inherited the desk or the piano from her grandfather. *suggests* Tia didn't inherit both the desk and the piano from her grandfather.

  g. Monika has pain in her forearm or her shoulder. *suggests* Monika doesn't have pain in both her forearm and her shoulder.

  h. Ellen discussed these issues with Martin or Adam. *suggests* Ellen didn't discuss these issues with both Martin and Adam.

  i. Jenny received a bill or an invitation in the mail today. *suggests* Jenny didn't received both a bill and an invitation in the mail today.

  j. Horatio complained about the staff or the meals to the manager. *suggests* Horatio didn't complain about both the staff and the meals to the manager.

  k. Jack purchased a sports car or a truck at the dealership. *suggests* Jack didn't purchase both a sports car and a truck at the dealership.

     l.   Toby finished his math or his history homework. *suggests* Toby didn't finish both his math and his history homework.

     m.   Fiona watched a movie or a tv show last night. *suggests* Fiona didn't watch both a movie and a tv show last night.

     n.   Peter borrowed a hammer or a screwdriver from Jason. *suggests* Peter didn't borrow both a hammer and a screwdriver from Jason.

(II)   **Either–or**

     a.   Jack gave Sue either champagne or jewelry for her birthday. *suggests* Jack didn't give her both champagne and jewelry for her birthday.

     b.   Toby sent Beth either a doll or a board game. *suggests* Toby didn't send Beth both a doll and a board game.

     c.   Terry bought either a blouse or a skirt. *suggests* Terry didn't buy both a blouse and a skirt.

     d.   Fiona talked with either Nigel or Jordan. *suggests* Fiona didn't talk with both Nigel and Jordan.

     e.   Becky invited either Sam or Rick to the ball. *suggests* Becky didn't invite both Sam and Rick to the ball.

     f.   Peter inherited either the painting or the wardrobe from his grandmother. *suggests* Peter didn't inherit both the painting and the wardrobe from his grandmother.

     g.   Pam has pain either in her thumb or in her elbow. *suggests* Pam doesn't have pain both in her thumb and in her elbow.

     h.   Ellen discussed these issues with either Martin or Adam. *suggests* Ellen didn't discuss these issues with both Martin and Adam.

     i.   Jenny received either a bill or an invitation in the mail today. *suggests* Jenny didn't received both a bill and an invitation in the mail today.

     j.   Horatio complained either about the staff or the meals to the manager. *suggests* Horatio didn't complain about both the staff and the meals to the manager.

     k.   Jack purchased either a sports car or a truck at the dealership. *suggests* Jack didn't purchase both a sports car and a truck at the dealership.

     l.   Toby finished either the math or the history homework. *suggests* Toby didn't finish both the math and the history homework.

     m.   Fiona watched either a movie or a tv show last night. *suggests* Fiona didn't watch both a movie and a tv show last night.

     n.   Peter borrowed either a hammer or a screwdriver from Jason. *suggests* Peter didn't borrow both a hammer and a screwdriver from Jason.

6.2. Experiment 3 critical trials

(III)   **Or**

     a.   Bill gave Mary flowers or chocolate for her graduation. *can you conclude that* Bill gave Mary only one these two things for her graduation.

     b.   Mark sent Jon a puzzle or a Gameboy for his birthday. *can you conclude that* Mark

sent Jon only one thing for his birthday.

c. Jeremy bought a tie or a hat at Target. *can you conclude that* Jeremy bought only one of these two at Target.

d. Danny met with Laine or Suzy before the conference. *can you conclude that* Danny met with only one of these two women before the conference.

e. Joanne invited David or Sabine to the party. *can you conclude that* Joanne invited only one of these two to the party.

f. Tia inherited the desk or the piano from her grandfather. *can you conclude that* Tia inherited only one thing from her grandfather.

g. Monica finished her math assignment or her history assignment. *can you conclude that* Monica finished only one of these two assignments.

(IV) **Either–or**

a. Jack gave Sue either champagne or jewelry for her birthday. *can you conclude that* Jack gave Sue only one of these two things for her birthday.

b. Toby sent Beth either a doll or a board game yesterday. *can you conclude that* Toby sent Beth only one of these two things yesterday.

c. Terry bought either a blouse or a skirt at Macy's. *can you conclude that* Terry bought only one of these two pieces of clothing at Macy's.

d. Fiona talked with either Nigel or Jordan at the bar. *can you conclude that* Fiona talked with only one of these two men at the bar.

e. Becky invited either Sam or Rick to the ball. *can you conclude that* Becky invited only one of these two men to the ball.

f. Peter inherited either the painting or the wardrobe from his grandmother. *can you conclude that* Peter inherited only one thing from his grandmother.

g. Pam finished either the ironing or the vacuuming while her mom was away. *can you conclude that* Pam finished only one of these two chores while her mom was away.

6.3. Experiment 4 critical trials (German)

(V) **Oder** ('or')

a. Bernd hat Maria Blumen oder Schokolade zum Geburtstag geschenkt. *legt nahe* Bernd hat Maria nicht Blumen und Schokolade geschenkt.

b. Markus hat Jan ein Puzzle oder einen Gameboy geschickt. *legt nahe* Markus hat Jan nicht ein Puzzle und einen Gameboy geschickt.

c. Sonja hat sich ein Kleid oder ein Shirt gekauft. *legt nahe* Sonja hat nicht ein Kleid und ein Shirt gekauft.

d. Daniel hat sich mit Luisa oder Susi getroffen. *legt nahe* Daniel hat sich nicht mit Luisa und mit Susi getroffen.

e. Janine hat David oder Sabine zur Party eingeladen. *legt nahe* Janine hat nicht David und Sabine zur Party eingeladen.

f. Ellen hat diese Fragen mit Martin oder Adam diskutiert. *legt nahe* Ellen hat diese

Fragen nicht mit Martin und mit Adam diskutiert.

g. Jenny hat eine Rechnung oder eine Einladung in ihrer Post. *legt nahe* Jenny hat nicht eine Rechnung und eine Einladung in ihrer Post.

h. Harald hat sich ber das Personal oder ber das Essen beim Manager beschwert. *legt nahe* Harald hat sich nicht ber das Personal und ber das Essen beim Manager beschwert.

i. Tina hat den Schreibtisch oder das Klavier von ihrem Grovater geerbt. *legt nahe* Tina hat nicht den Schreibtisch und das Klavier von ihrem Grovater geerbt.

j. Monika hat Schmerzen im Unterarm oder in der Schulter. *legt nahe* Monika hat Schmerzen nicht im Unterarm und in der Schulter.

(VI) **Entweder oder** ('either–or')

a. Jonas hat Susanne entweder Champagner oder Schmuck zum Geburtstag geschenkt. *legt nahe* Jonas hat Susanne nicht Champagner und Schmuck zum Geburtstag geschenkt.

b. Tobias hat Betty entweder eine Puppe oder ein Brettspiel geschickt. *legt nahe* Tobias hat Betty nicht eine Puppe und ein Brettspiel geschickt.

c. Tatjana hat entweder eine Bluse oder einen Rock gekauft. *legt nahe* Tatjana hat nicht eine Bluse und einen Rock gekauft.

d. Fiona hat entweder mit Norbert oder mit Johannes geredet. *legt nahe* Fiona hat nicht mit Norbert und mit Johannes geredet.

e. Beate hat entweder Samuel oder Richard zum Ball eingeladen. *legt nahe* Beate hat nicht Samuel und Richard zum Ball eingeladen.

f. Boris hat seinen Vorschlag entweder mit Janine oder Rafael abgesprochen. *legt nahe* Boris hat seinen Vorschlag nicht mit Janine und mit Rafael abgesprochen.

g. Ferdinand hat entweder ein Gutachten oder einen Scheck heute mit der Post erhalten. *legt nahe* Ferdinand hat nicht ein Gutachten und einen Scheck heute mit der Post erhalten.

h. Elisabeth hat sich entweder ber die Betten oder die Garage bei der Rezeption beschwert. *legt nahe* Elisabeth hat sich nicht ber die Betten und die Garage bei der Rezeption beschwert.

i. Peter hat entweder das Gemlde oder den Kleiderschrank von seiner Oma geerbt. *legt nahe* Peter hat nicht das Gemlde und den Kleiderschrank von seiner Oma geerbt.

j. Pamela hat entweder im Daumen oder im Ellbogen Schmerzen. *legt nahe* Pamela hat nicht im Daumen und im Ellbogen Schmerzen.

Modeling the exhaustivity inference of clefts: evidence from Ga (Kwa)[1]

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Abstract. Cross-linguistically, cleft structures are observed to give rise to an exhaustivity inference modeled in various ways. This paper argues based on the new data from Ga (Kwa) collected in Ghana that a distinction into collective and distributive predicates is an important factor interacting with the exhaustive interpretation of clefts.

Keywords: clefts, exhaustivity inference, collective and distributive predicates, Ga (Kwa)

1. Introduction

Cross-linguistically, clefts induce a structural bi-partition into the focused constituent and the backgrounded material. It is exemplified in (1), in which the focused constituent ('Klaus'), a so-called 'pivot,' is clearly separated from the backgrounded material.

(1)   Q: Wer hat gestern 'Schuld und Sühne' gelesen?
             who have yesterday 'Crime and Punishment' read
             'Who read 'Crime and Punishment' yesterday?'
      A: **Es war** Klaus, **der** gestern 'Schuld und Sühne' gelesen hat.
             it was Klaus that yesterday 'Crime and Punishment' read have
             'It was Klaus who read 'Crime and Punishment' yesterday.'

Cleft structures trigger an exhaustive interpretation (e.g., Percus 1997, Büring 2011, Velleman et al. 2012, Büring and Križ 2013), i.e., an inference that the pivot is interpreted as the only element satisfying the backgrounded description. Consider (1). It obtains the interpretation that Klaus read 'Crime and Punishment' yesterday and that nobody but Klaus read 'Crime and Punishment' yesterday. The latter is the exhaustive meaning.

There is an ongoing discussion on the nature of the exhaustive meaning triggered by clefts and on how to best model this inference.[2] Based on the novel data from Ga, I argue that a distinction into distributive-collective predicates is an additional compound that should be taken into consideration while accounting for the exhaustivity of clefts in a cross-linguistic perspective. Consider (2). Whereas (2-a) is judged to be acceptable by Ga native speakers, (2-b) is judged to be unacceptable:[3]

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[1]This paper is based on chapter 4 of my dissertation 'Exhaustivity. On exclusive particles, clefts, and progressive aspect in Ga (Kwa).'

[2]For the opposite view, i.e., that clefts do not trigger an exhaustive inference, see for example Pollard and Yasavul (2014).

[3]The glosses used in this paper are as follows: DET = determiner; SG = singular; 1 = First person; 2 = Second person; 3 = Third person; PRT = particle; NOM = nominalizer; NEG = negation; COMPL = complementizer; REL =

(2)   a.   Jeee Fred **ni** e-fɔ   nine e-tsɛ   lɛ. E-tsɛ   Fred kɛ Gord.
            NEG Fred PRT 3SG-throw hand 3SG-call PRT 3SG-call Fred and Gord
            'It wasn't Fred she invited. She invited Fred and Gord.'
      b.   #Jeee Kofi ni   Maria fɔ.   E-fɔ   Kofi kɛ Emmanuel.
            NEG Kofi PRT Maria give.birth 3SG-give.birth Kofi and Emmanuel
            'It's not Kofi to whom Maria gave birth. She gave birth to Kofi and Emmanuel.'

This paper aims at accounting for the contrast in (2). The outline of the paper is as follows. Section 2 gives an overview of the information structural properties of the Ga *ni*-structure (cleft).[4] Section 3 discusses its semantic properties. Subsequently, section 4 provides a syntactic and a semantic analysis of the Ga clefts and section 5 summarizes.

2. Information structural properties of the *ni*-structure

Ga (Kwa) is an under-researched Ghanaian language spoken in the Greater Accra Region by about 600.000 speakers. It has two tones: High and Low. All the data stem from the author's original fieldwork with four Ga native speakers in Accra and one Ga native speaker in Berlin. All of the language consultants grew up in a Ga speaking communities. The fieldwork methodology is based on Matthewson (2004).

The particle *ni* induces a structural bi-partition into the focused constituent to its left (a so-called 'pivot') and the backgrounded material to its right.[5] This view is based on the observation that the pivot is acceptable as an answer to wh-questions, as presented in (3). However, an element out of the pivot is not, as demonstrated in (4) and (5):

(3)   Q: Who ate banku yesterday?
      A: Kofi **ni**   ye banku nyɛ.
            Kofi PRT eat banku yesterday
            'It is Kofi who ate banku yesterday.'

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relativizer; COP = copula; IMPF = imperfective; PFV = perfective; PROSP = prospective; QPRT = question particle. An example marked with '*' means that the example was judged to be unacceptable in the given context and I hypothesize that it is for grammatical reasons, '#'/'??' also means that the example was judged as unacceptable in the given context but for semantic or pragmatic reasons; in the case of ?? the judgments were not so clear as in the case of '#'. Finally, examples without any diacritics were judged as acceptable in the given context.

[4]For arguments that the *ni*-structure should be analyzed as a cleft, see Renans (2016).

[5]The particle *ni* in Ga comes in two guises, i.e., namely as high tone *ní* and low tone *nì* (Dakubu 2005). The high-tone *ní* functions as a complementizer. On the other hand, there are two low tone *nì*s, where one functions as a conjunction and one introduces a cleft structure. In this paper, I analyze only the low tone *nì* introducing cleft structures. Therefore, the tone marking is omitted.

(4) Q: Namɔ (ni) kane wolo?   (5) Q: Mɛni (ni) Kofi ye nyɛ?
         who   PRT read book   what PRT Kofi eat yesterday
         'Who read a book?'   'What did Kofi eat yesterday?'
     A: #Wolo **ni**   Kofi kane.   A: #Kofi **ni**   ye abele.
         book PRT Kofi read   Kofi PRT eat corn
         'It is a book that Kofi read.'   'It is Kofi who ate corn.'

Another piece of data suggesting that pivots are restricted to be in focus is an observation that they cannot express aboutness topics, as presented in (6):[6]

(6)   Tell me something about John.
         A1:#John **ni**   kane wolo nyɛ.
            John PRT read book yesterday
         A2: John lɛ, e-kane   wolo nyɛ.
            John DET 3SG-read book yesterday
            'As for John, he read a book yesterday.'

Moreover, the particle *ni* has a rigid syntactic position, i.e., it can only occur just after the ex-situ focused constituent. Therefore, it cannot associate with focus from a distance, as demonstrated in (7), and it cannot attach to in-situ focused constituents, as shown in (8):

(7)   Q: Who read a book yesterday?
         A: Kofi **ni**   kane (***ni***) wolo (***ni***).
             Kofi PRT read PRT   book PRT
             'It is Kofi who read a book.'

(8)   Q: What did Kofi read yesterday?
         A1:*Kofi kane adesawolo **ni**   nyɛ.
            Kofi read newspaper PRT yesterday
         A2: Adesawolo **ni**   Kofi kane nyɛ.
            newspaper PRT Kofi read yesterday
            'It was a newspaper that Kofi read yesterday.'

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[6]Note that the particle *lɛ* has many functions, e.g., it functions as a topic/background marker and as a definite determiner (Dakubu 1992, Renans 2016). I gloss it DET.

3. Semantic properties of the *ni*-structure

3.1. The exhaustivity inference

That Ga *ni*-structures give rise to an exhaustivity effect which is suggested by the results of the tests discussed below.

3.1.1. Test #1: Conjunction of two clauses containing *ni*

The diagnostics demonstrated in (9) is based on the observation that one cannot conjoin two exhaustively interpreted clauses that differ only in the exhaustified constituent. If the particle *ni* does not give rise to the exhaustive interpretation, it should be possible to conjoin two sentences with the particle *ni* and the same VP-descriptions but with different elements in pivots, contrary to fact. Consider (9-a):

(9)   a. #Felix **ni** kane-ɔ   wolo ni Kofi **ni** kane-ɔ   wolo.
            Felix PRT read-IMPF book and Kofi PRT read-IMPF book
            'It is Felix who reads a book and it is Kofi who reads a book.'
        b. Felix kane-ɔ   wolo ni Kofi kane-ɔ   wolo.
            Felix read-IMPF book and Kofi read-IMPF book
            'Felix reads a book and Kofi reads a book.'

The unacceptability of (9-a) shows that a sentence with the particle *ni* is interpreted exhaustively. The acceptability of (9-b), on the other hand, suggests that sentences without *ni* are not exhaustive.

3.1.2. Test #2: É. Kiss's (1998) test for exhaustivity

This tests consists of a conversation between three people (A, B, and C). A asks a wh-question and B answers the question either with the use of the particle *ni* or an unmarked SVO word order. Finally, C negates B's answer using the additive particle *hu*.[7] The task of the language consultants was to judge whether C's statement is an acceptable reaction for the B's answer. Negation together with an additive particle in a sentence negates an exhaustive meaning. For example, (10-C) does not negate the meaning that Lisa bought a dress but that Lisa was the only person who bought

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[7]Note, however, that whereas the original target sentences were presented in the context which states that the described situation took place, e.g, the context for (10) would be that Lisa bought a dress yesterday, the contexts for the target sentences in this paragraph constitute wh-questions.

a dress, i.e., Maria bought a dress as well. Therefore, if B's answer is exhaustive, C's response to B should be judged as acceptable. Otherwise, C's response should be judged as unacceptable. Consider (10)–(11):

(10) A: Namɔ he   ataade nyɛ?
          who   buy dress yesterday
          'Who bought a dress yesterday?'
      B: Lisa **ni** he   ataade nyɛ.
          Lisa PRT buy dress   yesterday
          'It was Lisa who bought a dress yesterday.'
      C: Daabi, Maria hu   he   ataade nyɛ.
          No   Maria also buy dress   yesterday
          'No, Maria also bought a dress yesterday.'

(11) A: Mɛni Kofi ye nyɛ?
          what Kofi eat yesterday
          'What did Kofi eat yesterday?'
      B: Banku **ni**   Kofi ye nyɛ.
          Banku PRT   Kofi eat yesterday
          'It was banku that Kofi ate yesterday.'
      C: Daabi, Kofi ye amadãa hu   nyɛ.
          No   Kofi eat plantain also yesterday
          'No, Kofi ate also plantain yesterday.'

In both cases, the language consultants judged C's response to B's statement as acceptable. On the other hand, in cases when B replies with the use of an unmarked SVO order, C's response with the additive particle *hu* was judged as unacceptable, as presented in (12):[8]

(12) A: Namɔ tee   jara   lɛ nɔ nyɛ?
          who   go.PAST market DET on yesterday
          'Who went to the market yesterday?'
      B: Mark tee   jara   lɛ nɔ nyɛ.
          Mark go.PAST market DET on yesterday
          'Mark went to the market yesterday.'
      C: #Daabi, Emmanuel hu   tee   jara   lɛ nɔ nyɛ.
          no   Emmanuel also go.PAST market DET on yesterday
          'No, Emmanuel also went to the market yesterday.'

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[8]The language consultants commented that in that case C's answer does not make sense in the context of A and B's conversation.

Again, the contrast between (10)–(11) and (12) suggests that the *ni*-structure gives rise to an exhaustivity effect.

3.1.3. Test #3: Szabolcsi's (1981) test for exhaustivity

In this test the language consultants were presented with pairs of sentences. The 'a' sentence (context) in each pair contains a plural entity as the pivot and the 'b' sentence contains a singular entity as the pivot, i.e., a member of the plural entity from the 'a' sentence. The VP description in both sentences is the same. The task of the language consultants was to decide whether sentence 'b' is acceptable in the context of sentence 'a.' If the particle *ni* triggers an exhaustive interpretation, then 'b' sentence should not be acceptable in the context of sentence 'a.' Examples of the target pairs are presented in (13) and (14).

(13) a. context:
          Dora kɛ Lisa **ni** he ataade nyɛ.
          Dora and Lisa PRT buy dress yesterday
          'It was Dora and Lisa who bought a dress yesterday.'
      b. ?Lisa **ni** he ataade nyɛ.
          Lisa PRT buy dress yesterday
          'It was Lisa who bought a dress yesterday.'

(14) a. context:
          Banku kɛ amadãa **ni** Kofi ye nyɛ.
          banku and plantain PRT Kofi eat yesterday
          'It was banku and plantain that Kofi ate yesterday.'
      b. #Banku **ni** Kofi ye nyɛ.
          banku PRT Kofi eat yesterday
          'It was banku that Kofi ate yesterday.'

(15) a. context:
          Dora kɛ Lisa **ni** he ataade nyɛ.
          Dora and Lisa PRT buy dress yesterday
          'It was Dora and Lisa who bought a dress yesterday.'
      b. Lisa he ataade nyɛ.
          Lisa buy dress yesterday
          'Lisa bought a dress yesterday.'

Note the contrast between (13) and (15). (15-b) is acceptable in the context of (15-a), because

'Lisa' in (15-b) — due to the lack of the particle *ni* — is not interpreted exhaustively and therefore (15-b) is compatible with the scenario in which it was Dora and Lisa who bought a dress. By contrast, 'Lisa' in (13-b) is interpreted exhaustively and thus (13-b) is not compatible with the context in which it was Dora and Lisa who bought a dress. Therefore, (13-b) is unacceptable in the context of (13-a).

Even though the judgments regarding pairs of sentences with subjects as the pivot were not as clear as in the case of sentences with DOs as the pivot, the results still show that the *ni*-structure triggers an exhaustive interpretation.

3.1.4. Test #4: Hartmann and Zimmermann's (2007) test for exhaustivity

This test consisted of a context and a short dialogue between Kofi and his teacher. The language consultants were supposed to judge whether Kofi could deduce from the teacher's statement, and the accompanying context, whether he had passed the exam or not. Consider (16), taken from Hartmann and Zimmermann (2007):

(16)   context: A student (Kofi) who is anxious that he might have failed a test approaches a teacher and asks: 'Can you tell me whether I have passed or not?' Unfortunately, teachers are by law forbidden to tell a student directly about his or her result. However, there is no law forbidding them to talk about other students' performances.

     K: Ani   mi-paasi yɛ kaa lɛ   mli?
          QPRT 1SG-pass at exam DET in
          'Have I passed the exam'

     T: **Mi** kɛɛ-ŋ   bo shi Felix **ni** paasi-ko   yɛ kaa lɛ   mli.
          1SG tell-PROSP.NEG 2SG but Felix PRT pass-PFV.NEG at exam DET in
          'I cannot tell you but it is Felix who did not pass the exam.'

The language consultants decided that Kofi could deduce on the basis of the teacher's utterance (and the accompanying context) that he had passed the exam. Note that when the teacher uttered the same sentence without the particle *ni*, i.e., in canonical SVO word-order, Kofi could not deduce anymore whether he had passed the exam or not. It suggests that the exhaustivity inference, which enables the deduction whether Kofi passed the exam or not, is induced by the *ni*-structure.

3.1.5. Test #5: The *ni*-structure in mention-some contexts (Hartmann and Zimmermann 2012)

The particle *ni* cannot occur in mention-some contexts, as demonstrated in (17):

(17)   Mi-le   mɛi   pii   ní   hɔ̃ɔ akwadu yɛ jaanɔ.
            1SG-know people many REL sell banana at market.on
            'I know many people that sell banana at the market.'

     a. #Kofi **ni**   hɔ̃ɔ akwadu.
            Kofi PRT sell banana
            'It is Kofi who sells banana.'

     b. Kofi hu   hɔ̃ɔ akwadu.
            Kofi also sell banana
            'Kofi also sells banana.'

A sentence in (17-a), unlike (17-b), is not an acceptable continuation of (17) suggesting that the *ni*-structure gives rise to an exhaustivity effect. If the speaker knows a lot of people who sell banana, then Kofi cannot be the only person who sells banana. One of the language consultants gave a comment that (17-a) would be good as a corrective statement, meaning that not many people sell banana but Kofi.

3.2. The exhaustivity effect is not-at-issue

The previous subsection has shown that the *ni*-structure triggers an exhaustive interpretation. This in turn strongly suggests that its meaning can be characterized by the two meaning components, i.e., the prejacent and the exhaustivity inference:

(18)   Fred **ni**   e-kpee.
            Fred PRT 3SG-invite
            'It was Fred she invited.'

     a. *prejacent:* She invited Fred.
     b. *exhaustivity:* She invited nobody other than Fred.

The question is which of the meaning components listed in (18) is at-issue and which is not-at-issue.[9] A hypothesis, which comes from the behavior of *it*-clefts and exclusive particles in English (Büring 2011, Büring and Križ 2013, Horn 1981, Velleman et al. 2012, among others), is that the exhaustivity effect triggered by the particle *ni* is not-at-issue, in contrast to the exhaustivity effect triggered by the exclusive particle *pɛ* ('only'):

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[9]I follow Roberts et al. (2009), Simons et al. (2011), among others, in the assumption that whereas at-issue content addresses the main point of the utterance, not-at-issue does not. In more formal terms, while at-issue content addresses the Question Under Discussion (QUD) or raises a new QUD, not-at-issue content neither address QUD nor raises a new QUD.

(19)   PARTICLE *ni*   (20)   PARTICLE *pɛ* ('ONLY')

      a.   *at-issue:* prejacent   a.   *at-issue:* exhaustivity

      b.   *not-at-issue:* exhaustivity   b.   *not-at-issue:* prejacent

The hypothesis is tested against the results of several tests aimed at identifying at-issue and not-at-issue meaning components. First, consider examples (21)– (23), taken from Büring and Križ (2013):[10],[11]

(21)   a.   #Bob le   akɛ e-kpee   Fred shi e-le-ee   akɛ Fred **ni**   e-kpee.

                Bob know that 3SG-invite Fred but 3SG-know-IMPF.NEG that Fred PRT 3SG-invite

                'Bob knew she invited Fred, but he didn't know it was Fred she invited.'

      b.   Bob le   akɛ e-kpee   Fred shi e-le-ee   akɛ Fred **pɛ**   e-kpee.

                Bob know that 3SG-invite Fred but 3SG-know-IMPF.NEG that Fred only 3SG-invite

                'Bob knew she invited Fred, but he didn't know she invited only Fred.'

The fact that (21-a) is unacceptable suggests that the prejacent ('Fred was invited') rather than the exhaustive meaning component ('Nobody other than Fred was invited') is the at-issue content of a sentence with the *ni*-structure. If the prejacent is at-issue, then (21-a) says that Bob knew she invited Fred but he didn't know she invited Fred. This leads to a contradiction, which explains its unacceptability. If the exhaustivity was at-issue, then the contradiction would not occur, which is the case in (21-b), a version of (21-a) with the particle *pɛ*. (21-b) states that Bob knew she invited Fred but he did not know that she invited Fred and nobody else and therefore it is acceptable. Consider now (22), which is modeled after an example in Szabolcsi (1994):

(22)   a.   Jeee Fred **ni**   e-fɔ   nine e-tsɛ   lɛ. E-tsɛ   Gord (#hu).

                NEG Fred PRT 3SG-throw hand she-call PRT 3SG-call Gord ALSO

                'It wasn't Fred she invited. She invited Gord.'

      b.   Jeee Fred **pɛ**   e-fɔ   nine e-tsɛ. E-tsɛ   Gord #(hu).

                NEG Fred ONLY 3SG-throw hand 3SG-call 3SG-call Gord ALSO

                'She didn't only invite Fred. She also invite Gord.'

If the hypotheses in (19-b) and (20-b) are true, then in the case of (22-a) the prejacent is at-issue, and in the case of (22-b) the exhaustivity is at-issue. Since negation targets the at-issue meaning component, in (22-a) it is negated that Fred was invited. Thereby the additive particle *hu* in the second clause of (22-a) lacks the anaphoric antecedent which is required for its felicitous use and

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[10]Büring and Križ's (2013) examples, in turn, are modeled after similar sentence pairs in Horn (1981).

[11]The ambiguity of the third person singular pronoun (he vs. she) in Ga examples was clarified during elicitation sessions.

by that (22-a) is unacceptable. By contrast, in (22-b) the exhaustivity is negated; that is, (22-b) states that it is not the case that she invited Fred and nobody else and in that case the additive particle in the second clause is required.

The following examples provide further evidence that the exhaustivity inference triggered by the particle *ni* is not-at-issue and the exhaustivity effect triggered by the particle *pɛ* is at-issue:

(23)　　a.　#E-kpee　　Fred, shi jeee Fred **ni**　e-kpee.
　　　　　　　3SG-invite Fred but neg Fred PRT 3SG-invite
　　　　　　　'She invited Fred but it was not Fred she invited.'
　　　　b.　E-kpee　　Fred, shi jeee Fred **pɛ**　　e-kpee.
　　　　　　　3SG-invite Fred but NEG Fred ONLY 3SG-invite
　　　　　　　'She invited Fred, but she didn't only invite Fred.'

Negation in the second clause of (23-a) and (23-b) targets the at-issue meaning component, i.e., the prejacent and the exhaustive inference, respectively. Therefore (23-a) can be paraphrased as 'She invited Fred but she didn't invite Fred' which leads to a contradiction and thereby it is unacceptable. (23-b), on the other hand, states that she invited Fred but Fred was not the only person she invited which does not yield the contradiction and therefore (23-b) is acceptable.

The observation that the exhaustivity triggered by the particle *ni* is not-at-issue and the one triggered by the particle *pɛ* is at-issue is confirmed by the results of the test presented below. Its design is based on the methodology presented in Onea and Beaver (2009).[12] The test consists of pictures and their descriptions. The descriptions included either the *ni*-structure or the exclusive particle *pɛ*. The pictures, on the other hand, were designed to violate a potential exhaustive interpretation of the pictures descriptions. The language consultants were asked to correct the description if it does not correspond to what they can see in the picture. They could choose one out of three possible answers: 'Yes, ...,' 'Yes, but...,' or 'No, also x... .' Consider (24) and (25).[13,14]

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[12]Note, however, that originally Onea and Beaver (2009) did not use this methodology to discuss the (not)-at-issueness of the exhaustivity effect generated by clefts and 'only' but to show that the exhaustivity effect generated by exclusive particles is stronger than one generated by clefts (semantic vs. pragmatic effect). The results of this experiment are reinterpreted in Destruel et al. (2015) who claim that 'yes, but' answer does not check the source of the inference (pragmatics vs. semantics) but the status of the inference (at-issue vs. not-at-issue).

[13]Caption 'preferred answer' indicates answers chosen by the language consultants.

[14]Note that in the test presented in examples (10) and (11) the language consultants accepted 'No, also x' answer as the dissent of sentences with the *ni*-structure. I argue that it is due to the fact that while examples (10) and (11) constitute a categorial acceptability judgment test, example (24) is a multiple-choice task. In the first case, the language consultants accepted sentences with *ni*, because the *ni*-structure triggers an exhaustive interpretation. In the case of (24), on the other hand, they prefer 'yes, but' answer, because this effect is not-at-issue. Thank you to Malte Zimmerman (p.c.) for pointing this out to me.

(24)   picture: A girl (Dora) is holding an orange and a tomato.

A: Akwadu **ni**   Dora he.
        orange   PRT Dora buy
        'It was an orange that Dora bought.'

(i)   Hɛɛ ni   Dora he   amoo   hu.
         yes and Dora buy tomato also
         'Yes and Dora also bought a tomato.'

(ii)   Hɛɛ shi Dora he   amoo   hu.   ⇒ preferred answer
         yes but Dora buy tomato also
         'Yes, but Dora also bought a tomato.'

(iii)   Daabi, Dora he   amoo   hu.
         no   Dora buy tomato also
         'No, Dora bought also a tomato.'

(25)   picture: Two girls (Lisa and Eva) are eating oranges.

A: Lisa **pɛ**   ye-ɔ   akwadu bianɛ.
        Lisa only eat-IMPF orange   now
        'Only Lisa is eating an orange now.'

(i)   Hɛɛ ni   Eva hu   ye-ɔ   akwadu bianɛ.
         yes and Eva also eat-IMPF orange   now
         'Yes and also Eva is eating an orange now.'

(ii)   Hɛɛ shi Eva hu   akwadu ye-ɔ   bianɛ.
         yes but Eva also orange   eat-IMPF now
         'Yes, but also Eva is eating an orange now.'

(iii)   Daabi, Eva hu   ye-ɔ   akwadu bianɛ.   ⇒ preferred answer
         no   Eva also eat-IMPF orange   now
         'No, Eva is also eating an orange now.'

While in the case of the description with the *ni*-structure, example (24), the preferred answer is 'Yes, but,' in the case of the description containing the exclusive particle *pɛ*, example (25), the preferred answer is 'No, ...' The answers are in line with Tonhauser's (2012) claim that 'yes' and 'no' trigger an at-issue content. Moreover, Tonhauser (2012) uses assents/dissents with adversative continuation, such as example (25-ii), as one of the diagnostics for the at-issue content. 'The assumption is that utterances where adversative continuations convey the hypothesized at-issue content are contradictory, and hence unacceptable, while utterances where assent/dissent is followed by an adversative utterance that conveys hypothesized not-at-issue content are acceptable.' (Tonhauser 2012, p.245).[15] In (24-ii), 'yes' confirms the at-issue content, i.e., the fact that Dora bought an orange and 'but' triggers a comment on the not-at-issue content, i.e., the exhaustivity

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[15]The results are also in line with Destruel et al. (2015), who claim that 'yes, but' answer diagnoses a (not)-at-issueness of the inference.

inference. In sum, (24) can be paraphrased as 'Yes, Dora bought an orange but it was not the only thing she bought.' In (25), on the other hand, 'no' negates the at-issue content, i.e., the fact that nobody but Lisa is eating an orange. Hence, (25-iii) can be paraphrased as 'It's not the case that nobody but Lisa is eating an orange, Eva is also eating an orange.'

3.2.1. Exhaustivity is not cancellable

Ga data suggest that the exhaustivity effect triggered by *ni*-structures is not cancellable:

(26) $^?$Felix **ni** kane wolo nyɛ.   Ní Kofi hu   kane wolo nyɛ.
       Felix PRT read book yesterday and Kofi also read book yesterday
       'It was Felix who read a book yesterday. And Kofi also read a book yesterday.'

(27) #Banku **ni** Kofi ye nyɛ.   Ni amadãa hu   Kofi ye nyɛ.
       Banku PRT Kofi eat yesterday and amadaa ALSO Kofi eat yesterday
       'It was banku that Kofi ate yesterday. And he also ate plantain yesterday.'

While the language consultants gave mixed acceptability judgments regarding cancellation of the exhaustivity effect with the subject as the pivot, they gave clear judgments when the DO was the pivot. All in all the data suggest that the exhaustivity generated by the particle *ni* is rather not cancellable.

3.2.2. Problematic data

The data presented so far show that whereas the exhaustivity inference triggered by the *ni*-structure is not-at-issue, the exhaustivity triggered by the exclusive particle *pɛ* is at-issue. However, the picture is not quite so simple. Consider (28) in which the exhaustivity effect triggered by the *ni*-structure and *pɛ* seems to be of the same nature, which is problematic for the above generalization:

(28) Jeee Fred **ni** e-fɔ   nine e-tsɛ   lɛ. E-tsɛ   Fred kɛ Gord.
       NEG Fred PRT 3SG-throw hand 3SG-call PRT 3SG-call Fred and Gord
       'It wasn't Fred she invited. She invited Fred and Gord.'

To sum up, any analysis of clefts in Ga, the *ni*-structure, will have to account on the one hand for the not-at-issue non-cancellable exhaustivity inference triggered by clefts and, on the other, for the acceptability of (28).

4. Analysis

I propose modeling the semantics of the particle *ni* in line with the conditional exhaustivity proposed by Büring (2011):

(29)   It was Kofi who swam.

    a.   *assertion:* Kofi swam.

    b.   *presupposition:* If Kofi swam, then nobody else swam.
       if $P \in Q$, then $\{P\} = max(Q)$

Büring and Križ (2013) argue that Büring's (2011) theory makes the wrong predictions about the truth-value of sentences with collective predicates. Consider (30), taken from Büring and Križ (2013):

(30)   context: Bill and Fred carried the piano together, and neither of them did alone, nor did anyone else.

    T.   #It was Bill who carried the piano.

    a.   *assertion:* Bill carried the piano.

    b.   *presupposition:* If Bill carried the piano, then nobody else carried the piano.

Their argumentation against the conditional exhaustivity is as follows: Since Bill is not in the extension of the collective predicate 'carry the piano' (its extension includes only the plural individual Bill ⊕ Fred), the antecedent of the conditional in (30-b) is false. Therefore, the presupposition (the whole conditional) should be true irrespective of the truth value of the consequent. However, if Bill ∉ [[carry the piano]], then the assertion is false. Büring and Križ (2013) claim that this outcome is wrong because (30) is not false but neither true nor false, i.e., it suffers from the presupposition failure. In my opinion, however, given that it is very difficult to tear apart experimentally the presupposition failure from the falsity of the sentence (Abrusán and Szendrői 2013) — naive native speakers seem to have no intuitions to distinguish one from the other — Büring and Križ's (2013) analysis predicting the presupposition failure in the case of (30) is not superior over the theory predicting the falsity of (30).

Looking at Ga, I propose that the *ni*-structure has the following meaning components:

(31)   *ni*-STRUCTURE:

    a.   *assertion*: $P(x)$

    b.   *not-at-issue*: $P(x) \rightarrow x = max(P)$

Therefore, the lexical entry of *ni* is presented in (32):

(32) $[[\text{ni}]] = \lambda P.\lambda x : P(x) \rightarrow x = max(P).P(x)$

For illustration, the assertion and the not-at-issue meaning component of (33) in informal terms are given in (34). Its syntactic structure is presented in (35) and its truth conditions in (36).[16]

(33) Kofi ni sele.

(34) a. *assertion:* Kofi swim.
      b. *presupposition:* If Kofi swim, then Kofi is a maximal swimmer.

(35)
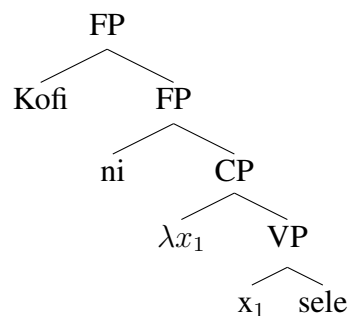
(36) $[[\text{FP}]]$ is defined only if $swim(Kofi) \rightarrow Kofi = max(\lambda x.swim(x))$, if defined then 1 iff Kofi swam

The conditional analysis of the exhaustivity triggered by clefts properly accounts for the data presented in section 3.1. First, it explains the exhaustivity effect triggered by the *ni*-structure, which in turn accounts for the unacceptability of (9-a) repeated below as (37). Namely, if Felix reads, then he is a maximal reader. Therefore, Kofi cannot be a maximal reader as well:

(37) #Felix ni kane-ɔ wolo ni Kofi ni kane-ɔ wolo.
      Felix PRT read-IMPF book and Kofi PRT read-IMPF book
      'It is John who reads a book and it is Kofi who reads a book.'

It also explains why Kofi could deduce whether he had passed the exam or not. If Felix did not pass the exam, then Felix is the maximal student who did not pass the exam. Thus Kofi can deduce

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[16]I argue that the *ni*-structure is a monoclausal structure in which the pivot is base-generated in its left peripheral position, see Renans (2016).

that he himself had passed the exam.

(38)   *Context*: A student (Kofi) who is anxious that he might have failed a test approaches
         teacher and asks: 'Can you tell me whether I have passed or not?' Unfortunately, teachers
         are by law forbidden to tell a student directly about his or her result. However, there is no
         law forbidding them to talk about other students performances.

        K: Ani   mi-paasi yɛ kaa   lɛ   mli?
             QPRT I-pass   at exam DET in
             'Have I passed the exam?'

        T: Mi kɛɛ-ŋ   bo shi Felix ni   paasi-ko   yɛ kaa   lɛ   mli.
             I   tell-cannot you but Felix PRT pass-PFV.NEG at exam PRT in
             'I cannot tell you but it is Felix who did not pass the exam.'

Second, since the exhaustivity inference is modeled as being not-at-issue, it accounts for the unac-
ceptability of (23), repeated below as (39), and other data presented in subsection 3.

(39)   #E-kpee   Fred, shi jeee Fred **ni**   e-kpee.
         3SG-invite Fred but neg Fred PRT 3SG-invite
         'She invited Fred but it was not Fred she invited.'

Even though the analysis can account for a wide range of data, it needs to be ameliorated in order
to account for the problematic data discussed throughout the chapter.

4.1. Problematic data

The conditional analysis of the clefts' semantics (Büring 2011) cannot explain the acceptability of
the data in (40):

(40)   Jeee Fred ni e-fɔ   nine e-tsɛ   lɛ. E-tsɛ   Fred kɛ Gord.
         neg Fred PRT 3SG-throw hand 3SG-call PRT 3SG-call Fred and Gord
         'It wasn't Fred she invited. She invited Fred and Gord.'

The problem arises already at the assertion level. The cleft sentence in (40) asserts that Fred was
not invited ($P(x)$, i.e., Fred $\notin$ [[invite]]). Conversely, the second sentence in (40) asserts that Fred
was invited (Fred $\in$ [[invite]]) leading to the contradiction.

I postulate a rescue strategy that allows to solve these problems. I argue that cleft structures in general and the *ni*-structure in particular require re-interpreting distributive predicates in a collective manner. Distributive predicates predicate of the singular individuals that make up the plural individual (e.g., Landman 1989). Therefore the following holds:

(41)   John and Bill shaved.

(42) $\text{shave}(\text{John} \oplus \text{Bill}) \rightarrow \text{shave}(\text{Bill})$

It follows that distributive predicates have singular entities in their denotation. By contrast, collective predicates predicate of plural individuals (e.g., Landman 1989), i..e, they have only plural individuals in their denotation. Thus the following is valid:

(43)   John and Bill met.

(44) $\text{meet}(\text{John} \oplus \text{Bill}) \nrightarrow \text{meet}(\text{Bill})$

Now, if 'invite' is interpreted distributively, then in example (40) the contradiction arises. It is caused by the fact that the assertion of the cleft is Fred $\notin$ [[invite]] and the second sentence asserts that Fred $\in$ [[invite]].

The situation is dramatically different, if 'invite' is re-interpreted in a collective manner. An informal paraphrase of (40) with the collective interpretation of 'invite' is given (45).

(45)   She did not invite a singular entity called Fred. She has invited a plural entity called Fred and Gord.

If 'invite' is interpreted collectively, then 'Fred' is not in the extension of 'invite.' However, a plural entity Fred $\oplus$ Gord is, i.e., Fred $\oplus$ Gord $\in$ [[invite]]. Therefore the rescue strategy can account for the contradiction which arises at the assertion level.

Consider now the presupposition triggered by the cleft structure in (40). It says that 'If Fred was invited, then he is a maximal invitee.' Since Fred is not invited, the antecedent of the conditional is false and thus the whole conditional presupposition is true, irrespective of the truth value of the consequent. This is a desired result, because it ensures that the presupposition can project out of the scope of negation without incurring a contradiction with information in the global context.

The postulated rescue strategy gives rise to clear, testable, empirical predictions. Namely, it predicts unacceptability of parallel examples with unambiguously distributive predicates which reinterpretation in the collective manner is impossible, as *to give birth*.[17] The prediction is borne out, as illustrated in (46):

(46)   #Jeee Kofi ni   Maria fɔ.   E-fɔ   Kofi kɛ   Emmanuel.
           NEG Kofi PRT Maria give.birth she-give.birth Kofi and Emmanuel
           'It's not Kofi to whom Maria gave birth. She gave birth to Kofi and Emmanuel.'

Importantly, the fact that example (40) with the re-interpretable predicate is acceptable and a parallel example (46) with the unambiguously distributive predicate is unacceptable suggests that the data cannot be accounted for with a sole reference to metalinguistic negation. If the acceptability of (40) was due to metalinguistic negation then also the negation in (46) should be interpreted metalinguistically leading to the acceptability of (46), contrary to fact.

The main point of this paper was to show that by modeling the exhaustivity effect of clefts, the distinction into collective vs. distributive predicate should be taken into consideration, at least in Ga. Note that the contrast in (2) can also be explained by other approaches to the exhaustivity effect triggered by clefts, e.g., Velleman et al. (2012), if they are ameliorated with the proposed pragmatic rescue strategy.[18]

5. Summary

This paper presented a series of empirical evidence showing that the cleft structure in Ga gives rise to the non-cancellable exhaustive interpretation. Importantly, the exhaustivity effect interacts with the collective vs. distributive interpretation of the predicate. This in turn poses challenges for many existing accounts for the exhaustivity of clefts. The pragmatic rescue strategy, which postulates the reinterpretation of the distributive predicates in clefts in a collective manner, can account for the problematic data, potentially in a cross-linguistic perspective.

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[17]In fact, the prediction is that either (i) is unacceptable or Kofi and Emmanuel are twins.

[18]See Renans (2016) for the arguments in favor of Büring's (2011) account.

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Deriving a Variable-Strength *Might*[1]

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Abstract. This paper combines an empirical argument about the lexical semantics of *might* with a preliminary description and theoretical account of a novel variety of implicatures. Empirically, I introduce the DISMISSIVE AGREEMENT paradigm, which shows that *might* semantically encodes nothing stronger than nonzero probability. Theoretically, I derive the fact that *might* often seems to suggest something stronger from the pragmatic norm that cooperative speakers will make claims that are strong enough to be relevant to the Question Under Discussion, which gives rise to LOWER BOUND IMPLICATURES.

Keywords: epistemic modality, implicature, QUD, relevance.

1. What's In This Paper

This is a paper about *might*. It begins with the observation that all theories of the semantics of *might* must assign to it either a WEAK meaning (*might* entails only that its prejacent is not strictly impossible) or a STRONG meaning (*might* can entail that its prejacent is more than merely non-impossible—that its prejacent is fairly likely, or is worth devoting attention to, or is especially plausible/normal/stereotypical). Though a broad variety of both weak and strong semantics for *might* have been proposed, no investigation of which I am aware systematically examines the empirical evidence supporting each view. This paper fills that gap.

The major empirical contribution of this paper is the DISMISSIVE AGREEMENT paradigm, which has not been discussed previously in the literature:

(1)   DISMISSIVE AGREEMENT:
      A: Paul might come to the party.
      B: Yeah, he might, but it's extremely unlikely.

That it's possible to agree with a *might*-claim while simultaneously dismissing it as extremely unlikely is very difficult to reconcile with many theories of *might*. In §2 I present the relevant theoretical arguments in tandem with an investigation of novel data and conclude that *might* can only be WEAK. I briefly present a standard weak semantics for *might* in §3.

However, the intuitions underlying the STRONG family of theories of *might* are palpably clear, and deserve explanation. In §4 I propose that strengthening of *might* can be derived from standard Gricean reasoning. I propose that QUDs are accompanied by PROBABILITY GRAINS that legislate the grain size of probability relevant to answering that QUD; the assumption that cooperative speakers will only point out differences in probability that are large enough to be relevant causes *might*-claims to generate a LOWER BOUND IMPLICATURE, which pragmatically strengthens their meaning. In §5 I elaborate on the nature of Probability Grains, in §6 I explore some differences between the behavior of lower bound implicatures and the behavior of scalar implicatures, and in §7 I argue that lower bound implicatures are not particular to *might*, and in fact can be seen occurring with a broader variety of existentials.

2. The Empirical Terrain: Weak or Strong?

I'll call sentences like (2) *might*-claims:

    (2)   Paul might weigh 180 pounds.

In sentences like this, *might* takes scope over its prejacent (*Paul weighs 180 pounds* in the sentence above) and, roughly speaking, converts it from an assertion that the prejacent is true to an assertion that the prejacent could possibly be true. I will refer to a *might*-claim with prejacent p as *might-p*.

What precisely does a *might*-claim entail of its prejacent? A WEAK theory of the semantics of *might* takes *might-p* to entail only that p is not strictly impossible. For instance, Kratzer (1977) proposes that *might-p* is true iff there is at least one epistemically accessible world in which p is true, and Veltman (1996) proposes that an update with *might-p* doesn't alter any context that already contains at least one world in which p is true. In contrast, a STRONG theory of *might* allows *might-p* to entail something more of p. For instance, Kratzer (1981) associates *might* with 'human possibility', on which account *might-p* is true iff there is at least one world in a special subset of especially likely/plausible/normal worlds in which p is true, and Willer (2013) associates *might* with 'live possibility', such that an update with *might-p* has the effect of establishing p as a possibility that should be taken seriously. Some theories, like those of Swanson (2006) and Lassiter (2011), take *might-p* to entail that the likelihood of p is greater than a contextually specified threshold value; I lump these theories in with the strong theories, because they allow for *might-p* to entail something stronger than that p is not impossible, though they do not necessitate that it always entails something stronger.

The intuition behind strong theories is clear. Consider the following *might*-claim in its given context:

    (3)   *Context: Your friend Paul lives on the East Coast. You haven't heard from Paul in a while, and know nothing of his plans or specific whereabouts. I assert the following to you:*

Paul might come to our party in Santa Cruz next weekend.

A natural response to my assertion would be for you to feel surprised, and to assume that I have access to some evidence or information about Paul's plans and whereabouts. If all that my *might*-claim communicated was that its prejacent is not impossible, it would be puzzling for you to be surprised by my statement, as you know nothing that rules out the possibility of Paul making his way to Santa Cruz by next week; likewise, there would be no reason to assume that I have access to any particular information about the prejacent, because it does not require any special knowledge to have realized that Paul coming to Santa Cruz next week is not strictly impossible.

That *might*-claims often seem strong is demonstrated even more clearly by considering dialogues like the following:

(4)   **A:** Paul might come to the party.
      a. **B:** Oh really? I didn't know that!
      b. **B:** I guess we should buy some more snacks!

B reacts to **A**'s *might*-claim as though **A** has said that it's fairly likely that Paul will come to the party, or that Paul coming to the party is a possibility that deserves serious attention. Presumably, **B** did not think it was strictly impossible that Paul would come, and yet she can announce that she was unaware of the contents of the *might* claim, as in (4a); (4b) seems like a sensible response to **A**'s assertion, even though buying extra snacks to accommodate Paul only makes sense if there's a fairly large chance that he'll come. **B**'s response to **A**'s *might*-claim is perfectly congruent with a strong theory of *might*, but is *prima facie* mysterious from the perspective of a weak *might*.

The following dialogue makes a similar point:

(5)   **A:** Will Paul come to the party?
      B: He might.

A's question indicates that she isn't ruling out the possibility that Paul will come, but that she isn't certain that he will either. If **B**'s *might*-claim communicated only that it's not impossible that Paul will come to the party, it should be a strictly uncooperative response, as it merely reiterates a possibility that **A**'s question indicates that she is not ruling out. However, **B**'s response feels like an informative contribution. Again, this makes perfect sense from the perspective of a strong theory of *might*, but is somewhat mysterious on a weak theory.

Data like the above make it quite clear that *might*-claims can communicate something stronger than that their prejacent is merely non-impossible. However, I've chosen the word 'communicate' carefully. That a sentence has the effect of communicating some information in context

does not necessitate that the semantic content of that sentence entails that information. If we use entailment-sensitive tools to probe *might*-claims, it's easy to see that the strength observed above is not semantic. Consider the following contradiction tests:

(6)   a. An asteroid might wipe out all life on Earth tomorrow, but it's a truly remote possibility, and it's not worth worrying about.
       b. Running the Large Hadron Collider might destroy the universe, but it's so astronomically unlikely that it's not a relevant consideration.

If the intuitive strength *might*-claims was hard-coded into their semantics, we would expect conjunction of *might-p* with an expression that p is implausible or extremely unlikely or irrelevant or not worth paying attention to result in contradiction. As the data in (6) demonstrate, this is not the case: *might-p* conjoined with a sentence dismissive of p's likelihood or relevance is perfectly coherent. This data is on its own perhaps insurmountably problematic for theories in which *might*-claims always entail something stronger than the non-impossibility of their prejacent. However, they are not necessarily problematic for a theory in which *might-p* entails that p is more likely than a contextual threshold value. Consider this denotation for *might-p*, taken from Swanson (2006) with minor notational modifications:

(7) $[\![might\text{-}p]\!]^{M,w,g} = 1$ iff $prob([\![p]\!]^{M,w,g}) > \alpha$
       Where *prob* is a function from propositions to probabilities, and α is a contextually determined threshold.

A theory based on such a denotation for *might-p* could deal with this data by proposing that conjoining *might-p* with an assertion that p is very unlikely simply forces accommodation of a very low value for α, such that α lies beneath the cutoff point for unlikeliness, so as to avoid contradiction.

At this point, I'll introduce novel data that shows that even the flexibility provided by a contextual threshold theory of *might* cannot account for the full range of empirical facts:

(8)   **A:** Paul might come to the party.
       a. **B:** Yeah, he might, but it's extremely unlikely.
       b. **B:** #Well, though it's not impossible that he'll come, you're wrong that he might, because it's so unlikely.

(8a) is an example of DISMISSIVE AGREEMENT: **B** agrees with the *might*-claim, but her response nonetheless feels dismissive, as it goes on to characterize the prejacent as extremely unlikely. The possibility of dismissive agreement makes the same point as the contradiction tests above.

However, crucially for the feasibility of strong theories of *might* that involve contextual thresholds, (8b) shows that the inverse of dismissive agreement is impossible: it is bizarre and contradictory to explicitly acknowledge that p is not impossible but go on to reject a *might*-claim on the basis of the implausibility of its prejacent. This should be acceptable on a threshold-based theory, because for any nonzero valuation of α it is perfectly possible for the likelihood of p to fall beneath α without p being impossible.

Dan Lassiter (p.c.) points out corpus data like the following, in which a *might*-claim is rejected in a context that suggests that what is being rejected is that its prejacent is likely, not that its prejacent is possible:

(9)   Bats are very good at flying—they have to be if they want to fly around in the dark! So it's just not true that a bat might get tangled in your hair.
       (retrieved from http://rtejr.rte.ie/shutterbugs/shutterbugs-blog/2014/10/bats/ on 11/6/2015)

In this example, it's not the case that there's truly no chance whatsoever that a bat will get tangled in your hair, it's just unlikely enough that it seems reasonable to dismiss the possibility. In §4 I develop a pragmatic account of strengthening that predicts that in most contexts *might*-claims will strengthen; (9) shows that *might*-claims can be rejected/dismissed on the basis of their strengthened meanings. This is a pragmatic phenomenon; the crucial *semantic* fact demonstrated by (8b) is that rejecting a *might*-claim gives rise to contradiction if its prejacent has been *explicitly* acknowledged to be possible earlier in the utterance.

I conclude on the basis of the novel data examined in this section that only a weak semantics for *might* is fully compatible with the empirical landscape.

3. The Semantics of *Might*

I assume the following weak semantics for *might*:

(10) $\llbracket might\text{-}p \rrbracket^{M,w,g} = 1$ iff $P_w(\llbracket p \rrbracket^{M,w,g}) > 0$
       Where P_w is a function from propositions to degrees of epistemic likelihood at w such that for all propositions ϕ, ψ, if $\phi \subseteq \psi$ then $P_w(\phi) \leq P_w(\psi)$.[2]

(11)   cf. the denotation given in Kratzer (1977) (with slight notational modifications):
       $\llbracket might\text{-}p \rrbracket^{M,w,g} = 1$ iff $\exists w \in$ EPIST-WORLDS$_w$ s.t. $w \in \llbracket p \rrbracket^{M,w,g}$
       Where EPIST-WORLDS$_w$ is the set of worlds epistemically accessible from w.

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[2]Whether the function P_w represents a finitely additive probability measure, as in Yalcin (2010), or maps to a cruder, rougher-grained scale of intuitive likelihood is irrelevant for the proposal at hand. What is crucial is that it represents epistemic likelihood, not objective likelihood.

The denotation given in (10) is a notational variant of Kratzer (1977)'s seminal account presented in (11), given the assumption that a world w' is epistemically accessible from w iff $P_w(\{w'\})$ > 0. Lassiter (2011 a.o.), Yalcin (2010 a.o.), Swanson (2006 a.o.), and Moss (2015) argue that the semantics of epistemic modals should make direct reference to probabilities; extensions of the Kratzerian theory of modality into degree-based frameworks have been developed by Klecha (2014), Grosz (2009) and Katz (2015). The account given below works equally well in probabilistic, classical Kratzerian and degree-based semantics of epistemic modals. The only crucial assumption I make is that the pragmatics is sensitive to degrees of likelihood; I remain agnostic about whether direct reference to probabilities or degrees is necessary in the semantics of epistemics. I've chosen the notation in (10) over Kratzer's simply for notational parsimony, because I'm going to be dealing with likelihood scales in the pragmatic account of strengthening below.

4. Lower Bound Implicatures

Given a weak semantics for *might*, how can we explain the intuition that many *might*-claims communicate something strong? There is a simple, intuitive reason why a claim that some proposition p is not impossible should tend to convey that p is fairly likely, or that p is a possibility worth considering: trivially small probabilities are seldom relevant, and so for an assertion that the probability of p is nonzero to be a relevant contribution to an average conversation, it must be taken to mean that the probability of p is fairly substantially above zero. In this section, I'll develop an implementation of that intuition in a formal pragmatics that is almost completely standard.

The only non-standard piece of the pragmatics that I assume comprises my novel theoretical contribution: the idea that Questions Under Discussion (QUDs—q.v. Roberts 1996 & Ginzburg 1996) come packaged with a specification of the grain size of probability that is relevant with respect to their answers, called PROBABILITY GRAINS. Given a scale of degrees of epistemic likelihood running from 0, indicating epistemic impossibility, to 1, indicating complete epistemic certainty, I define PROBABILITY GRAINS (PGs) like so:

(12) PROBABILITY GRAINS:
      A Probability Grain PG_n ($n \geq 2$) is the unique tuple of n threshold values in ascending order $< t_1, \ldots, t_n >$ that comprises a uniform partition of [0,1] (the unit interval)

(13) a. A COARSE Probability Grain: $PG_4 = < 0, .33, .66, 1 >$

           0   .33   .66   1
           ├──────────────────────┼───────────────────────┼──────────────────────────┤

      b. A FINE Probability Grain: $PG_{11} = < 0, .1, .2, .3, .4, .5, .6, .7, .8, .9, 1 >$

           0   .1   .2   .3   .4   .5   .6   .7   .8   .9   1
           ├─────┼─────┼─────┼─────┼─────┼─────┼─────┼─────┼─────┼─────┤
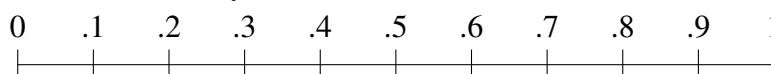
A Probability Grain partitions the epistemic likelihood scale into a set of equivalence classes; members of an equivalence class are not considered to be RELEVANTLY DIFFERENT from each other.[3]

(14)   RELEVANT DIFFERENCES:
       Relative to a Probability Grain $PG_n = < t_1, \ldots, t_n >$, any number $n' \in [0,1]$ is not RELE-
       VANTLY DIFFERENT from a threshold value t_i unless $n' \leq t_{i-1}$ or $n' \geq t_{i+1}$

For any Probability Grain PG_n, $t_1 = 0$ and $t_n = 1$. As n grows higher, PG_n partitions the unit interval into more and more equivalence classes, and therefore more and more fine-grained distinctions in probability become relevant relative to the Probability Grain. A Probability Grain PG_i is COARSER than a Probability Grain PG_j iff $i < j$; if PG_i is COARSER than PG_j, then PG_j is FINER than PG_i. If a PG partitions the likelihood scale into very few equivalence classes, I will abuse terminology by referring to it as COARSE, and if a PG partitions the likelihood scale into many equivalence classes, I will abuse terminology by referring to it as FINE.

Probability Grains are a way of formally representing the fact that very fine-grained probabilistic distinctions are irrelevant to most conversations. If we're talking, for example, about whether Paul will come to the party, we're not likely to care overmuch about whether there is a 55% chance versus a 56% chance that Paul will come—we care whether he's definitely coming or definitely not coming, and we probably also care about a couple of intermediate probabilities as well: for example, we probably also care to know whether he's probably coming, or probably not coming. In the system I'm proposing, this is cashed out formally by saying that (in most default contexts) the QUD *Will Paul come to the party?* is associated with a Coarse Probability Grain.

The PG associated with a QUD is taken into account by Gricean reasoning about cooperativity when an answer to that QUD expresses a range of probabilities. Consider the dialogue in (5), repeated here as (15):

(15)   **A:** Will Paul come to the party?
       B: He might.

Let's assume for the sake of argument that **A**'s question is associated with the Coarse PG given in (13a). The semantic contribution of **B**'s response is simply that Paul coming to the party is not epistemically ruled out:

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[3]The representations in (13) are quite similar to representations deployed by Krifka (2006) to account for (im)precision in the use of number words. For Krifka, however, such coarse- and fine-grained tuples represent coarser- and finer-grained scales, not coarser- and finer-grained ways of partitioning an underlying continuous scale, and there's no element of pragmatic enrichment via implicature to the way he deploys them.

(16)
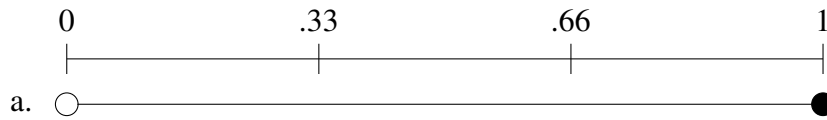
16a = semantic contribution of *might-p*

A white circle represents an exclusive bound, and a black circle represents an inclusive bound. The semantic contribution of *might-p*, given in (10) and depicted visually in (16), is merely that the epistemic probability of *might-p* is not 0. Any degree of likelihood other than 0 is compatible with the truth conditions of *might-p*. However, 0 is t_1 in the QUD's PG; a probability is only *relevantly* different than 0 if it is at least as high t_2, which, because the QUD's PG is very rough, is substantially higher than 0. This is where Gricean reasoning comes into the picture.

The guiding assumption of Gricean reasoning (Grice 1975) is that inferences beyond the literal meaning of a statement can be derived in non-adversarial conversations from the assumption that the speaker is being cooperative, with cooperativity defined (at least in part) in terms of:

(I) giving only accurate and well-substantiated information	(QUALITY)
(II) giving as much information as is necessary	(QUANTITY)
(III) presenting information parsimoniously	(MANNER)
(IV) keeping contributions relevant to the discussion at hand	(RELATION)

Gricean reasoning about the strength of *might-p* relative to a PG proceeds in the following way: the speaker's semantic contribution is simply that $P(p) \neq 0$, or, equivalently, that $P(p) \neq t_1$.[4] However, if the speaker believed that $P(p) < t_2$, her meaning would not be strong enough to be a relevant answer to the QUD; $P(p)$, though technically different from 0, would not be relevantly different. If the speaker was being cooperative, she must mean to communicate that $P(p)$ is *relevantly* larger than 0, i.e. that $P(p) \geq t_2$:

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[4]I omit the w subscript from P_w here and throughout the rest of the paper—P should always be taken to represent epistemic likelihood at the world of evaluation.

(17)
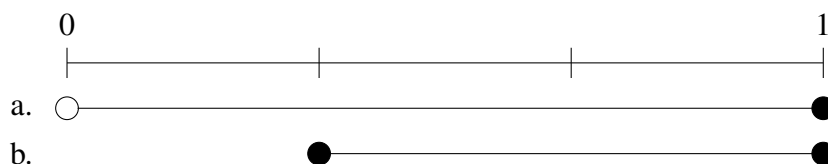
17a = semantic contribution of *might-p*

17b = pragmatically enriched lower bound

The intuitive strength of *might*-claims is an implicature generated by a conspiracy of QUANTITY and RELATION: it follows from the assumption that the speaker's meaning is strong enough to be relevant to the QUD. I'll refer to these implicatures as LOWER BOUND IMPLICATURES, as the implicature has the result of raising the lower bound of the range of probabilities the *might*-claim communicates.[5]

Gricean reasoning also gives us an explanation for why, as remarked on in the discussion of (3), *might*-claims often give rise to the inference that the speaker has access to information or evidence about the prejacent: it follows from QUALITY that an assertion that the epistemic probability of the prejacent is (substantially) nonzero must be justified by good evidence if the assertion is cooperative.

Thinking about things in these terms also gives us a clear explanation for how dismissive agreement works. The dismissive agreement example in (8a) is repeated in (18):

(18)   **A:** Paul might come to the party.
       B: Yeah, he might, but it's extremely unlikely.

In this example, **B** first agrees with **A**'s *might*-claim, and then goes on to dismiss the prejacent as extremely unlikely. Assuming that the range of probabilities that *extremely unlikely* denotes falls to the left of t_2 in the QUD's PG (i.e., that we're in a context where extremely unlikely possibilities are not relevant), consider the effect of agreeing with a *might*-claim while also asserting that its prejacent is extremely unlikely:

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[5]Horn (1984) calls the class of implicatures that have the property of 'inducing lower-bounding implicata' R-IMPLICATURES. He does not discuss implicatures of the precise kind that I've called lower bound implicatures here, focusing instead on phenomena like *I broke a finger yesterday* implicating *I broke my own finger yesterday*. Though there are some similarities between the R-Implicatures Horn discusses and the lower bound implicatures I discuss here, there are also significant differences.

(19)

no overlap!
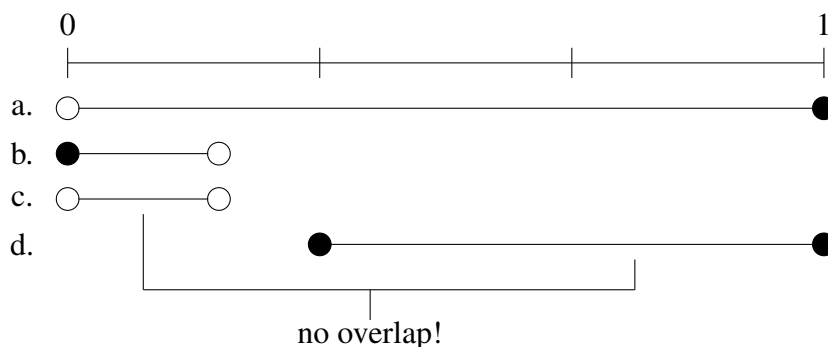
19a = semantic contribution of *might-p*

19b = semantic contribution of *extremely-unlikely-p*

19c = full semantic package (*might-p* + *extremely-unlikely-p*)

19d = relevantly nonzero portion of the scale

In dismissive agreement, an agent agrees with a *might*-claim while also asserting that its prejacent is extremely unlikely; if the portion of the likelihood scale picked out by *extremely unlikely* is a subset of the portion that is not relevantly different from 0 for the purposes of the current QUD, then dismissive agreement is pragmatically identical to asserting that the *might*-claim was an irrelevant contribution. The pragmatic account developed above gives us an explanation for why **B**'s response in (8a) appears superficially to be agreement while still feeling like a rejection of the original *might*-claim: **B**'s response is only non-contradictory if one cancels the implicature that the *might*-claim is strong enough to be relevant. **B** agrees with **A**'s statement, but goes on to (implicitly) reject the implicature that the prejacent is likely enough to be relevant.

It's worth pointing out that *might* interacts with various operators that appear to legislate its relation to the QUD's PG:

(20) a. **A:** Paul might come to the party.
         B: No, that's extremely unlikely.

      b. **A:** Paul {technically might, might in principle} come to the party.
         B: #No, that's extremely unlikely.

      c. **A:** Paul very well might come to the party.
         B: #Yeah, he very well might, but it's extremely unlikely.

(20a) shows that it's possible to disagree directly with the pragmatically enriched form of a *might*-claim; the *might*-claim can be rejected because its prejacent isn't likely enough. In (20b), however, that is no longer possible: when *technically* or *in principle* is added to the *might*-claim it becomes

infelicitous to reject it on the grounds that the prejacent, though not impossible, is very unlikely. In **B**'s response in (20c) we see that dismissive agreement is rendered infelicitous if the dismissive agreer adds *very well* to a *might*-claim before going on to dismiss it.

My interpretation of these facts, informally, is as follows: *technically* and *in principle* preclude the generation of lower bound implicatures. They signal that the *might*-claim should not necessarily be taken to communicate RELEVANTLY nonzero probability. **B**'s response in (20b) is infelicitous because **A** indicated that a lower bound implicature should not be generated. However, *very well* does the opposite: it strenthens a *might*-claim's communication of RELEVANTLY nonzero probability from an implicature to an entailment. *very-well-might-p* entails that $P(p) \geq t_2$ in the QUD's PG.

I'll call such operators RELEVANCE OPERATORS because of the way they appear to affect the status of the assumption that an assertion is strong enough to be relevant to the current QUD (either calling it off, or strengthening it into an entailment). A formal theoretical model of the semantico-pragmatics of such operators lies far outside the scope of this paper, but strikes me as a very exciting avenue for future work.

5. More About Probability Grains

The discussion of strengthening implicatures in the previous section used a Coarse Probability Grain to show how a weak semantics can implicate a stronger interpretation if small distinctions in probability are irrelevant to the conversation. Although in many conversations such small distinctions are irrelevant, there are conversations in which participants care quite a bit about very small distinctions in probability; my account predicts that in such situations *might*-claims will tend to be interpreted more weakly. One example of such a conversation would be a conversation about particle physics among a group of expert scientists. Because very fine-grained differences in probability could matter a great deal in such a conversation, we would expect some QUDs arising in the course of the conversation to be associated with quite Fine Probability Grains, relative to which only small amounts of strengthening will occur. The prediction that my theory makes about such a conversation is that *might*-claims would generally not be taken by participants to communicate substantially nonzero probability, because very small probabilities are not irrelevant to the conversation. That prediction accords with my intuition.

One crucial distinction between a conversation about who is going to come to a party and a conversation about how subatomic particles interact is the fine-grainedness of the probabilistic information available in principle about each question. It is difficult to see how one would obtain information that would differentiate between a 55% and a 56% chance that someone will attend a party; however, such information is obtainable about many physical interactions. I assume that the fine-grainedness of probabilistic information obtainable in principle about the answers to a question acts as an upper limit on the Fineness of the PG associated with that question, though sometimes what is relevant to a QUD may be Coarser than the fineness of probabilitic information

available in principle.

It should be noted that the full machinery of Probability Grains is not necessary to generate the strengthening effects I've used them to model. A system in which a QUD specifies a minimum threshold that probabilities must reach before they become relevant would accomplish the same effects for *might*-claims. Such an instantiation would be a very simple variant on the semantic threshold account endorsed by Swanson (2006) and Lassiter (2011); the only difference would be locating the threshold in the pragmatics instead of in the semantics of *might*. I've chosen to present the PG system above instead of a simpler threshold-based formulation because the PG system allows us to make principled predictions about which contexts will be the most likely to provoke the most strengthening of *might*-claims, and because it makes principled predictions about interactions with the upper end of the scale as well—namely that contexts in which we expect *might*-claims to be the strongest should also be contexts in which the most skepticism is expressed by an assertion that a proposition p is not certain.

In most cases, PGs are implicit—it is rarely explicitly stated that a probability is only relevantly different from 0 if it is at least .05, for instance. For this reason, we would expect that participants in a conversation will interpret *might*-claims not as strengthening to a particular degree of likelihood as their lower bound; instead, we would expect strengthening to a somewhat vague and nebulous value, in view of listeners' uncertainty about the PG their interlocutors are assuming. However, this is not the case for all conversations. As an example of a QUD accompanied by an explicit relevance threshold, consider the following:

(21)   *Context: **A** is teaching a probability class, working through a story problem about stocks.*
       ***B** is her student.*
       A: Which stocks have at least a 5% chance of rising today?
       B: Apple, Facebook and Google stock all might rise in value today.

A's question makes explicit that she is only interested in stocks with at least a 5% chance of rising; **B**'s *might*-claim in this context communicates (defeasibly) that there is at least a 5% chance that Apple, Facebook and Google stock will rise, which is exactly what my theory predicts.

6. The Typology of Implicatures

In this paper I've introduced the novel empirical paradigm of dismissive agreement. In this section, I'll explore that paradigm a little more deeply, and use it to identify differences in the behavior of lower bound implicatures and scalar implicatures. Consider the following facts:

(22)   **A:** Paul might come to the party.
       *Context: **B** believes that the prejacent is possible but very unlikely.*

   a.   **B:** Yeah, he might, but it's extremely unlikely.

   b.   **B:** No, that's extremely unlikely.

   c.   **B:** #No, you're wrong that he might come, because it's extremely unlikely.

The case of dismissive agreement in (8a) is repeated in (22a). (22b) repeats the observation in (20a) that it is possible to disagree directly with the pragmatically enriched meaning of the *might*-claim; **B** rejects **A**'s assertion on the basis of the prejacent not being relevantly likely. However, (22c) shows that in the same context, disagreement is infelicitous if it overtly targets the *might*-claim. If **B** believes the prejacent to be possible, just unlikely, she can't explicitly target the *might*-claim for disagreement in order to reject only its pragmatically enriched meaning.

This is somewhat surprising, because it is well known that negation can be used metalinguistically with some kinds of implicatures to reject only the implicated content, without rejecting the literal meaning of the expression. For example, consider the following scalar implicatures plugged into the paradigm above:

(23)   **A:** Paul might come to the party.

   a.   **B:** Yeah, he might come—in fact, he'll definitely come.

   b.   **B:** No, he'll definitely come.

   c.   **B:** No, you're wrong that he might come—he'll definitely come.

Existential meanings tend to implicate the negation of related universal meanings (Horn 1972, Gazdar 1979). As a special case of such scalar implicatures, *might*-claims tend to implicate that the prejacent is not definitely true. (23) demonstrates how these implicatures pull apart from lower bound implicatures in terms of their interaction with disagreement. Scalar implicatures behave the same as lower bound implicatures in terms of dismissive agreement (23a)—it is coherent to agree with the *might*-claim before going on to reject the scalar implicature. (23b) shows that it is possible to disagree directly with the implicated content—**B** doesn't disagree with the semantic contribution of **A**'s utterance, she disagrees only with its pragmatically enriched meaning. (23c) is where the two types of implicatures pull apart: unlike in (22c) we see here that the *might*-claim itself can be targeted for disagreement when what is being rejected is not the semantics of the *might*-claim, but its scalar implicature.

It appears that the ability to target only the implicature with metalinguistic negation is not a general property of implicated content. Why would we only see metalinguistic negation with scalar implicatures, not lower bound implicatures?

I believe that the explanation for this distinction can be traced to a difference in what drives the computation of each type of implicature. Since Horn (1972), scalar implicatures have been understood to be triggered by the presence of a scalar element: *might* is on a scale with *definitely*, and its presence in a sentence implicates the negation of a sentence in which it has been replaced with its stronger scalemate. Lower bound implicatures, as discussed above, are not triggered by the mere fact of the presence of *might* in the sentence—they result from the evaluation of the semantics of the full sentence relative to the QUD. To sloganeer: scalar implicatures are LEXICAL, while lower bound implicatures are CONTEXTUAL.

This distinction explains the metalinguistic negation asymmetry above if we assume that metalinguistic negation targets some aspect of the *form* of an utterance. Because scalar implicatures are lexical, it makes sense that the use of the word *might* can be targeted for metalinguistic negation when what is being rejected is only the implicature—after all, it was the use of the word *might* that gave rise to the implicature. This explains the fact that (23c) sounds best with heavy emphasis on *might*, which serves to highlight which aspect of the form of the utterance is being targeted by metalinguistic negation. However, because lower bound implicatures are about the interaction between sentence meanings and QUDs, it is not the form of the utterance that gave rise to the implicature, and so it doesn't make sense to target the *might*-claim with metalinguistic negation.

Targetability by metalinguistic negation is not the only difference between lower bound implicatures and scalar implicatures. They also respond differently to focus. It has been widely noted that scalar implicatures are foregrounded or strengthened when the existential element bears focus. However, lower bound implicatures are not foregrounded or strengthened when the existential element bears focus:

(24)   Paul MIGHT come to the party.
    a.   *Strongly implicates: It is not certain that Paul will come to the party.*
    b.   *Does not strongly implicate: There is a large chance that Paul will come to the party.*

This may also be traceable to the fact that scalar implicatures are triggered by the lexical item, but lower bound implicatures are not: maybe focusing the existential foregrounds the scalar implicature by drawing attention to the fact that the existential was chosen instead of one of its stronger scalemates.

I leave a fuller investigation of the empirical facts about the interaction between lower bound implicatures and focus to future work.

7. Extension To Other Existentials

Above, I've described lower bound implicatures as arising from an interaction between the weak semantics of *might* and the notion that very small probabilities are usually not relevant to QUDs.

That the formalization pursued above is instantiated in terms of degrees of likelihood may have suggested that lower bound implicatures are specific to epistemic claims that can be construed as making reference to probability. However, the same crucial phenomena occur for other existentials. In this section, I will focus exclusively on *some*. Consider the following sentence:

(25)   Paul read some of the assigned article (but didn't finish it).

The literal meaning of this sentence is quite weak: there is some portion of the assigned article (perhaps trivially small, like two sentences) that Paul read. However, just like with *might*-claims, what gets communicated is somewhat stronger. In a normal context, this sentence communicates that Paul read a relevantly large portion of the assigned article; perhaps the introduction. The line of reasoning is the same as the reasoning detailed above for *might*-claims: trivially small portions of the article are not relevant to the discussion at hand. It seems sensible to assume that it is not cooperative to respond to a QUD like *Who read some of the assigned article?* by pointing out that Paul read the first two sentences.

Strengthening inferences for *some* behave just like strengthening inferences for *might*:

(26)   **A:** Paul read some of the assigned article.
   a.   **B:** Yeah, but he only read two sentences.
   b.   **B:** No, he only read two sentences.
   c.   **B:** #It's false that Paul read some of the article, because he only read two sentences.

Dismissive agreement (26a), disagreement with the strengthening implicature (26b), and the infelicity of targeting the existential claim for disagreement while acknowledging that a nonzero amount of cake was consumed (26c) all support the hypothesis that the inference that Paul read a relevantly large portion of the article is a lower bound implicature.

Though the formalism proposed above for lower bound implicatures with *might* makes specific reference to degrees of likelihood, it can be treated as a formula for explaining lower bound implicatures with a broader variety of existentials. The necessary machinery to explain the lower bound implicature that (25) gives rise to is quite comparable to the machinery necessary to explain lower bound implicatures with *might*-claims: assume that QUDs specify the grain size of quantity that is relevant to their answers; the *some*-claim will pragmatically strengthen such that the quantity communicated is relevantly different from 0.

I leave a fuller investigation of lower bound implicatures with the complete range of existential operators (as well as an investigation of the prospects for a unified account of such implicatures for different kinds of existentials) to future work.

8. Conclusion

I've made two major arguments in the course of this paper. The first is an empirical argument about the semantics of *might*. I've argued on the basis of contradiction tests and the dismissive agreement paradigm that *might* is semantically weak. The fact that many theorists of epistemic modality have proposed a strong semantics for *might* can be taken as a methodological parable: it is well known that expressions of natural language can communicate more than their literal semantic meaning; therefore, one must make sure that an aspect of the meaning of an expression in context is truly semantic before hard-wiring that aspect of meaning into the denotation of the expression.

The second argument I've made here is a theoretical argument about the pragmatics of *might*-claims. I've argued that the apparent strength of *might*-claims falls out of a standard formal pragmatics enriched with specifications of the relevant grain size of probability relative to the QUD. If very small distinctions in probability are irrelevant to the QUD, then listeners who assume their interlocutors are being cooperative will strengthen their interpretation of the lower bound communicated by a *might*-claim in accordance with the assumption that the *might*-claim contributes relevant information. It's not surprising that existential claims would strengthen in the way described in this paper: existential meanings can be extremely weak, and extremely weak claims are rarely relevant. I hope that the strengthening mechanism explored here for *might*-claims will become a special case of a more general formula for using the standard techniques of Gricean pragmatics to derive stronger, more relevant meanings from weak claims.

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Representing the effort in resolving ambiguous scope

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Abstract. This work proposes a way to formally model online scope interpretation in terms of recent experimental results. Specifically, it attempts to reconcile underspecified representations of semantic processing with results that show that there are higher-order dependencies between relative quantifier scope orderings that the processor may assert. It proposes a constrained data structure and movement operator that provides just enough specification to allow these higher-order dependencies to be represented. The operation reflects regression probabilities in one of the cited experiments.

Keywords: ambiguous scope, neo-Davidsonian semantics, online sentence processing

1. Introduction

In this paper, I reconcile conflicting factors in the representation of quantifiers and their scopes, particularly in the context of incremental parsing. Recent results in experimental psycholinguistics appear to suggest that higher-order constraints over scope ambiguity resolution seem to operate in the actual behaviour of language users (see section 2.2); these higher-order constraints have often been encoded in the theoretical linguistic literature as restrictions on covert movements, e.g., Quantifier Raising (QR; May, 1985). However, there are clearly pragmatic factors at play in how listeners choose scope order. The apparent complex interaction of these factors calls for a formal approach that accommodates three factors: (1) the incremental construction of the semantic representation, (2) the online pragmatic decision-making capacity of the processor, and (3) the formal/algorithmic constraints on ambiguity resolution. I use the aforementioned recent results to illustrate the challenge, and I present the outlines of a formal approach that hinges around the neo-Davidsonian event variable as the anchor that unifies both the pragmatic and algorithmic components of reanalysis and ambiguity resolution.

1.1. Scope and incrementality

Scope is a property of human language that connects syntax, semantics, and pragmatics, exposing aspects of the interfaces between each of them. The basic phenomenon of scope presents itself as follows: a logical operator that binds some variable within an area of syntactic or semantic structure. Insofar as there are multiple overlapping operators and scopes, there is potential for ambiguity. For example,

(1) Every child climbed a tree.

could mean either that there is a single tree that all the children climbed (inverse scope) or that for each child, there is a tree which that child climbed (linear scope). In this case, it may be that lexical-pragmatic bias about children and tree-climbing prompts a multiple-tree interpretation. However, sometimes these interpretations are constrained by grammatical factors. The sentence

(2) A tree that every child climbed was damaged.

is considerably more constrained to be a single tree, but not because of a "child-climb-tree" lexical-pragmatic relationship.

Ruys and Winter (2011) provide a thorough recent survey of approaches to the question of scope, but most of their examples come from traditional theoretical approaches that deal with scope ambiguity "offline". Offline scope ambiguity retains its ambiguity at the end of the sentence and is ideally tested in the absence of pragmatic bias.

Consider the sentence:

(3) Some woman admires every man.

Both readings (that there is a single woman who admires all the men or that each man has a woman who admires him) are difficult for many English-speakers to disambiguate without more context. In actual interaction, however, ambiguity comes and goes throughout the process.

(4) Some woman $\|_1$ admires every man. $\|_2$ These women $\|_3 \ldots$

At $\|_1$, the possibility that there could be a set of women involved is established. At $\|_2$, the ambiguity may be fully established, given no other context. At $\|_3$, the inverse interpretation is established. This involves costs that may accrue to cognitive or formal limits on the representation of meaning or to the cost of registering pragmatic or contextual information.

1.2. Movement, compositionality, and incrementality

If we make the assumption that some form of computational tractability must play a role in representing the operation of the human parser, then we would prefer as much as possible to eliminate the role of movement-style operations from the grammar (Kroch and Joshi, 1985). Thus, parsing formalisms rarely include space for QR-style operations. Formalisms that rely on a highly com-

positional semantics, such as categorial grammar, either simply omit covert operations from their representation or are required to posit highly divergent parallel representations; if there are a large number of scopal items, there may be a proliferation of parallel representations during the parse, to an extent implausible even under parallel architectures of processing, since most parallel parsing approaches use a search space of limited breadth (Staub, 2015)[1].

Formalisms that rely on less aggressively compositional mechanisms, such as neo-Davidsonian semantic formalisms (Parsons, 1990), avoid some of the problems of parallel computation and backtracking, but nevertheless confront the same problem in the incremental context: how to represent the possibilities of scope ambiguity resolution in the semantic output representation. But from where does this conflict ultimately stem?

At root, the problem is that it is challenging to represent the possibility of scope ambiguity in an incremental context, because incrementality by definition forces representations of the input to be only partially available, and yet linguistic constraints on interpretation are sometimes created by objects that are late in appearing. To resolve this conflict, predictive frameworks for syntactic parsing (e.g., Roark et al., 2009) attempt to match human behaviour in experimental settings by employing a form of *underspecification* (e.g., Ebert, 2005). At each step in the parse, the parser posits a structure with constraint-laden placeholders for future structure that may come with words not yet seen in the parse. The quality of the predictions and their match to human behaviour is controlled by fine-tuning the appearance of these placeholders and the costs of satisfying their constraints.

In the remainder of this work, we proceed through some arguments for and against underspecification approaches to scope representation. We describe a couple of recent experimental results that show that there are higher-order constraints on the interpretation of scopal ambiguities that "pure" underspecification grammars cannot represent. Keeping in mind the benefits of underspecification, we then describe an approach to accommodating higher-order scope interpretation effects by admitting a very limited form of movement that pertains to scope relationships – effectively, a type of stripped-down QR. We then return to the psycholinguistic results and describe how our system accommodates those facts.

2. Underspecification: for and against

2.1. For underspecification in scope

Underspecification approaches avoid generating the full listing of possible scope order interpretations until it is actually necessary, instead producing a compact description of the possibilities.

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[1]This is not *entirely* salvaged by the idea that most of these readings may be pragmatically excluded. Consider a quantifier arriving late in an pragmatically implausible position. If the parser has already made commitments to a particular derivation, it would require considerable backtracking to return to a more plausible derivation, restating the problem in terms of a covert operation of backtracking.

Given the sentence,

(5) Every child climbed a tree.

we find that there are two ways to interpret the relationship between the existential and universal quantifiers, $\forall > \exists$ and $\exists > \forall$. Without further evidence from the context, we can instead use a placeholder operator to say that there *should* be a dominance relationship between the two, without having to enumerate them all: $\exists \approx \forall$. Koller et al. (2010) show that it is possible to identify a vast number of readings from simple narrative sentences, even if some of these can be identified as semantically equivalent *post hoc* – which they do through the use of an underspecification formalism. They also find that potential ambiguities are relatively common; their annotation effort on the German-language NEGRA corpus finds that 121 of 322 annotated sentences potentially contain a scope relationship.

Underspecification theories of scope treat readings as equivalent unless otherwise required: they contain no default hierarchy. Although (5) seems to suggest that there was a different tree for every child, Dwivedi (2013) suggests that this effect may stem merely from the pragmatics of the situation, because sentences like

(6) Every jeweller appraised a diamond.

do not, experimentally, have so strong a bias, as language users are more willing to believe that there is a single diamond appraised by all the jewellers. Underspecification theories allow us to abstract away from pragmatically-driven aspects of interpretation; all that matters is achieving a compact representation of what is and is not allowed.

Dwivedi (2013) used reading time experiments involving sentences with two quantifiers preceding continuation sentences. She compared conditions under which the first sentence describes a scenario with a strong pragmatic bias vs. when they do not, as in:

(7) a. Every child climbed a/that/those tree(s). The tree(s) was/were in the park.
     b. Every jeweler appraised a/that/those diamond(s). The diamond(s) was/were clear and flaw-
        less.

Dwivedi found that sentence pairs such as that in (7-a) take less time to read when left scopally am-biguous (with *a*), while scope ambiguity has no effect on the reading time of the second sentence. On the other hand, in a question-answer task about the number of trees, she found that the singular variant of the second sentence with a scopally ambiguous first sentence produces chance accu-

racy rates (subjects disprefer the inverse interpretation that there is a single tree that all children climbed).

In sentence pairs such as (7-b), she finds the same effect for the first sentence, with unambiguous scope taking longer to read. On the other hand, the second sentence takes longer to read when the first sentence is scopally ambiguous. That is, the reduced lexical-pragmatic bias of the verb requires the processor to acknowledge the specification of number when the continuation sentence is given (subjects update their expectations of number). However, many subjects once again have difficulty when a question-answer task is used to force an inverse reading; it is possible, but dispreferred.

On the face of it, we can interpret this as strong evidence for a split system in scope processing: one in which there is a conceptual level that is specified only insofar as there is previous lexical bias on the verb; otherwise, underspecification applies until further information updates the scope expectations at this conceptual level. Then there is an algorithmic level which remains underspecified until a reading is forced, and this again costs some effort.

2.2. Against underspecification in scope

But while it appears that underspecification is present in the grammar, the extent to which underspecification applies is a matter of debate. Dwivedi's experiment involved sentences with two quantifiers. Dotlačil and Brasoveanu (2015) point out that it is difficult to draw distinctions between theories when the evidence involves only two quantifiers. We can use the influence of lexical-pragmatic bias in Dwivedi's result as an example. There are only three possible combinations, $\forall > \exists$, $\exists > \forall$, and $\exists \approx \forall$, the latter being the "default" under an underspecification story. Lexical-pragmatic information can force a specification, one that is complete for the entire sentence. But given a third quantifier, there remain unspecified possibilities. Under a "pure" underspecification story, the relationship of the third quantifier can remain unresolved indefinitely. But does it? Dotlačil and Brasoveanu (2015) experimented with adding a third quantifier, and their reading-time results show that there are higher-order relationships between quantifier specifications that cannot really be accommodated in a pure underspecification framework.

Dotlačil and Brasoveanu (2015) tested sentences like these on adult speakers:

(8) A caregiver (x) comforted a child (y) every night (n).
    a. The caregivers wanted the children to get some rest. ($\forall n > \exists x \exists y$)
    b. The caregivers wanted the child to get some rest. ($\forall n > \exists x$)
    c. The caregiver wanted the children to get some rest. ($\forall n > \exists y$)
    d. The caregiver wanted the child to get some rest. ($\exists x \exists y > \forall n$)
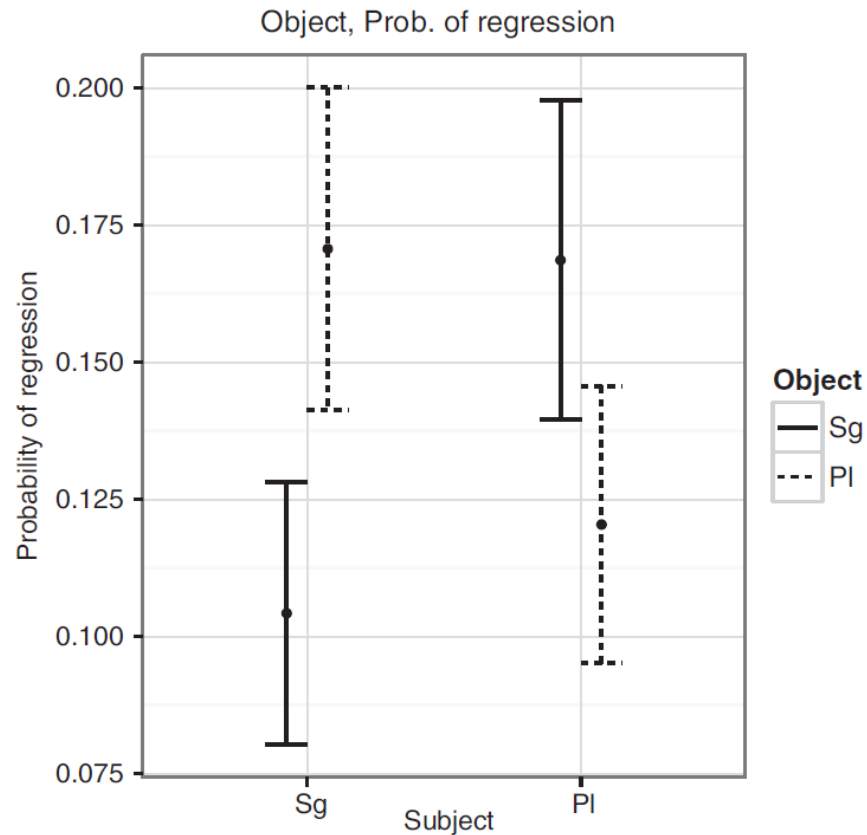
Figure 1: Probability of regression at the object in the continuation sentence. The result for re-reading probability is similar. Result from Dotlačil and Brasoveanu (2015).

In an eye-tracking setting, Dotlačil and Brasoveanu presented a sentence like (8) to a given subject, and then one continuation from (8-a)-(8-d). The crucial details of their result are in Figure 1, which shows the probability of regression for the object in the continuation sentence.

In summary, they found that in (8-a), there is a facilitating effect of the plural reading of "caregiver" on the plural reading of "child". The presence of a singular reading of "child" after a plural reading of "caregiver" (8-b), on the other hand, forces regressions and re-readings. In a purely underspecified framework, the readings of "caregiver" and "child" should be independent of one another; that they are dependent implies that there is a default structure already posited by the parser, that is defeated by the forced raising of "every night" on encountering the plural. On the other hand (8-d) is a kind of "baseline" scenario, in which "shallow" processing creates the linear order, and no covert operations are required. Finally, (8-c) is the complete leftward raising of "every night", leading to plural readings for both "caregiver" and "children"; the difference between it and the both-singular construction is not large.

Here, apparently *contra* Dwivedi, we have a result that does require a "higher-order" dependency between scope constraints, one revealed by the presence of the third quantifier. In both cases, however, the distinction is largely detected between the first and second sentences. Thus, it is not completely correct to say that the results contradict one another; without the third quantifier, the result from Dwivedi can be subsumed by that from Dotlačil and Brasoveanu, as there is no possibility of a higher-order dependency.

How do we draw a line in order to define exactly *how much* underspecification we need? An experiment by Radó and Bott (2011) may be useful in this case. They tested German sentences of the form :

(9) Genau ein Affe   ist auf allen/jeder Karte(n) zu finden.
    Exactly one monkey is on all/each   card(s)   to find.

They used self-paced reading followed by a display of cards with sets of images that may or may not contain a progression of monkeys; each card was revealed one-by-one in the same manner as the self-paced reading, and subjects were solicited to respond whether the statement has been proven true or false by the cards displayed so far, or whether they need more information (by revealing more cards). Compared with a control sentence with a single quantifier, subjects tended to have higher response times on the very first picture card, suggesting that the scopes were already fully specified by the time the card was read; the doubly-quantified sentence required the subject to examine the entire card, in order to confirm the truth of *exactly one*. On the other hand, Radó and Bott tested inverse linking versions of (9) (*Exactly one monkey on all/each card(s)...*) and found that there was no reading slowdown at *all/each*, while there was when the verb stood between the quantifiers, suggesting that the verb creates a minimal domain in which scope is computed when the second quantifier is seen.

3. Scope trees

Putting Dwivedi (2013), Dotlačil and Brasoveanu (2015), and Radó and Bott (2011) together, we see evidence for a model that does deep, pragmatically-influenced processing of scopes, but only at the completion of some form of "minimal scope domain". Thereafter the processing is potentially subject to higher-order algorithmic constraints that prevent an analysis that is fully underspecified, only positing constraints whenever there is direct evidence in the string.

Other evidence for the importance of processing domain in scope interpretation includes Syrett and Lidz (2011) who find that children and some adults do not respect a tensed clause barrier in antecedent-contained deletion (ACD) interpretation; they suggest that online processing capacity affects QR-constraining ability. Specifically, they test ACD sentences of the form:

(10) Miss Piggy wanted to drive every car that Kermit did.

Most adults take this sentence to imply that for every car that Kermit must have driven, Miss Piggy must have wanted to drive that car. That is to say, the quantifier in the deleted portion of the sentence remains within the scope of the "drive"-clause, and the deleted portion is the infinite regression "...drive every car that Kermit did drive every car that Kermit did ...". However, many more children than adults take the quantifier to raise to the matrix portion, implying that for every car Miss Piggy wanted to drive, Kermit wanted to drive that car too: "...want to drive every car that Miss Piggy did want to drive every car...".

Syrett and Lidz suggest that this may have to do with a reduced ability in children to distinguish between the matrix and embedded VPs, so that children more often resolve the ambiguity by raising the quantifier to the "wrong" VP in ellipsis resolution.

Sayeed and Demberg (2013b) propose an approach to the joint incremental representation of syntactic and semantic processing that allows for maximum underspecification at the level of predicate calculus. This TAG-based syntactic formalism makes use of the neo-Davidsonian event variable as a formal device that provides a great deal of representational flexibility. It allows the output semantic expression to grow mostly rightwards:

(11) a. A caregiver comforted ...
      b. $\exists x \mathsf{caregiver}(x) \wedge \exists e \mathsf{comfort}(e) \wedge \mathsf{agent}(x,e)$
      c. A caregiver comforted a child.
      d. $\exists x \mathsf{caregiver}(x) \wedge \exists e \mathsf{comfort}(e) \wedge \mathsf{agent}(x,e) \wedge \exists y \mathsf{child}(y) \wedge \mathsf{patient}(y,e)$

Sayeed and Demberg (2013a) then propose a system that represents ambiguous variable scopes without having to resort to inference rules that require the direct editing of the semantic representation. They do this by proposing a parallel structure called a "variable scope tree" (VST), in which strictly the participants in covert operations (event and entity variables) are contained in relations analogous to a syntactic tree. Then QR-style restrictions can be imposed over an operation called VST-move, which uses the event variable as a ceiling over QR.

3.1. Defining the VST system

The variable scope trees (VSTs) contain three types of nodes, event nodes, entity nodes, and traces. The event node simply contains the event variable. The entity node contains an entity variable

along with a quantification[2]. Event and entity nodes can have child nodes. Event nodes can have entity nodes or other events nodes as children. When an entity node is a child of an event node, it normally represents that the entity variable is fulfilling a semantic role in the event. Some events assign roles to other events, so an event node can be a child of an event node[3].

Trace nodes are coindexed with entity (or event) nodes in a manner familiar to movement theories of syntax. Trace nodes are generated only at the application of the "VST-move" operation. In the VST formalism, traces are currently used in the representation of the history of the derivation.

C-command is the principle means by which a VST is interpreted. The order of sisters under a parent node does not matter. When a node bearing a scope operator c-commands another node, it takes scope over it. Traces, as above, are currently only formal entities and are not subject to scope.

VST-move is also relatively familiar to recent movement theories of syntax. VST-move targets a node other than a root node, detaches it, replaces it with a coindexed trace, and makes the node a sister of an ancestor node. The ancestor node is copied to become its own parent as well as the parent of the reattached node. VSTs are not necessarily binary-branching, but the result of VST-move is a binary branching node.

VST-move with events and entities is limited by a ceiling. Specifically, nodes can only move to the most immediately containing event. This can be voided if there is some kind of semantic identity or overlap between two events. However, nodes can also only move to the root node. Together, these constraints have an effect of defining an equivalent to the Phase Impenetrability Condition. In other words, in the VST system, the event variable functions as a kind of minimal domain. Results such as Syrett and Lidz can be explained by memory constraints "blurring" event variables together, creating escape-hatches for otherwise illicit raising.

3.2. Online VST construction

How do we construct a VST? We describe this in terms of improvements we now propose to Sayeed and Demberg's system that enhance the generally rightward expansion of semantic expressions under parsing while allowing us to account for observations we have so far described.

In keeping with the incremental aims of this formalism, construction of a VST happens in parallel to the syntactic parsing procedure. A compatible incremental syntactic parser should generate one

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[2]For now, I am restricting this to quantificational noun phrases; other kinds of scope-bearing elements may introduce other types of variables, such as, for example, discourses and situations.

[3]An event node can be the child of an entity node in the case of a relative clause, a condition we leave for future work.

or more neo-Davidsonian terms with every word processed. The terms are processed as soon as they arrive and are used to expand the VST. These terms are usually connected by conjunctions or implications, depending on the introduction of universal or existential quantifiers (and nuclear and restriction scope). Because we use the VST to handle scope relations, we replace all logical operators between terms with a generic connective operator $\bullet$.

An initial "root" event is assumed. Whenever a term representing a predicate contains a binary relation that mentions a variable ready in the VST, the lowest node representing the variable is expanded with a copy of that variable as the first child and the unmentioned variable as its sister. In other words, if event e is already in the VST, the term $\mathsf{Role}(e, x)$ is sent by the parser, and x is already bound by the universal quantifier, then the lowest node mentioning e is expanded to have children e and $\forall x$. Event variable expansion pushes the existential event quantifier to the lower variable in compliance with Champollion (2011), in which the event variable's quantifier normally takes the lowest scope in the event.

I now provide an example of the incremental construction of a VST using the sentence in (8). At the beginning of the parse, we have:

(12) a. $\|$ *A caregiver comforted a child every night.*
      b. **Semantic expression**: $\emptyset$ (empty expression)
      c. **VST**: $\exists \mathbf{e}$

We mark the variables introduced via semantic output expression terms with in italics and the variable to be expanded in the next step with bold.

Now we process the first word, which gets us only one term.

(13) a. A $\|$ *caregiver comforted a child every night.*
      b. **Semantic expression**: $\mathsf{agent}(e, x)$
      c. **VST**: e
                                                            $\exists x \quad \exists \mathbf{e}$

The semantic expression does not contain the quantifiers. Instead, these are mentioned strictly in the tree, allowing the VST to be the sole representation of scope. As described above, the existential quantifier on e is lowered.

(14) a. A caregiver $\|$ *comforted a child every night.*
      b. **Semantic expression**: $\mathsf{agent}(e, x) \bullet \mathsf{caregiver}(x)$

c. **VST**:

$$e$$
$$\exists x \quad \exists \mathbf{e}$$
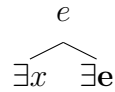
The introduction of "caregiver" gives us no additional information as to the variables, so it only introduces a term.

(15) a. A caregiver comforted ‖ *a child every night.*
    b. **Semantic expression**: $\mathsf{agent}(e, x) \bullet \mathsf{caregiver}(x) \bullet \mathsf{comforted}(e)$
    c. **VST**:

$$e$$
$$\exists x \quad \exists \mathbf{e}$$
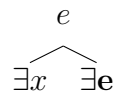
"Comforted" also produces nothing new in the VST, as no new variables are introduced.

(16) a. A caregiver comforted a ‖ *child every night.*
    b. **Semantic expression**: $\mathsf{agent}(e, x) \bullet \mathsf{caregiver}(x) \bullet \mathsf{comforted}(e) \bullet \mathsf{patient}(e, y)$
    c. **VST**:

$$e$$
$$\exists x \qquad e$$
$$\exists y \quad \exists \mathbf{e}$$
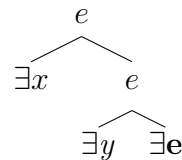
Once we have the second determiner, we obtain a new variable and expand the event node once again. "Child" will include no new variable information, so I will skip over that step for the purposes of explanation. Instead, the arrival of "every" introduces a new role-filler, but without telling us the role.

(17) a. A caregiver comforted a child every ‖ *night.*
    b. **Semantic expression**: $\mathsf{agent}(e, x) \bullet \mathsf{caregiver}(x) \bullet \mathsf{comforted}(e) \bullet \mathsf{patient}(e, y) \bullet \mathsf{child}(y) \bullet \underline{\quad}(e, n)$
    c. **VST**:

$$e$$
$$\exists x \qquad e$$
$$\exists y \qquad e$$
$$\forall n \quad \exists \mathbf{e}$$
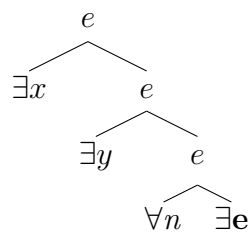
A properly incremental semantic parser would be aware that a role is upcoming without actually knowing what role is heralded by the appearance of "every". Consequently, we use ⎯ as a place-

holder.

Finally, the expression is completed with the arrival of "night". The VST is already complete, but "night" specifies the role of time/occurrence.

(18) a. A caregiver comforted a child every night. $\|$
   b. **Semantic expression**: $\mathsf{agent}(e, x) \bullet \mathsf{caregiver}(x) \bullet \mathsf{comforted}(e) \bullet \mathsf{patient}(e, y) \bullet \mathsf{child}(y) \bullet$ $\mathsf{OCCUR}(e, n) \bullet \mathsf{night}(n)$
   c. **VST**:
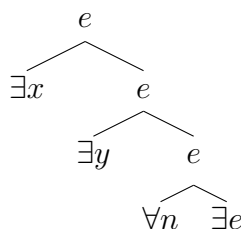
At each point in the parse, it is possible to apply VST-move to obtain alternative scope interpretations based on the demands of pragmatics, when enough variables are available. These are not obligatory; these are optional and are thus adaptable to experimental results in incremental scope resolution. Nevertheless, these are highly constrained, as not all possible movements are available (permitting, among other things, the development of tractable probabilistic models of scope resolution).

4. Accounting for reanalysis under specification

Now I will accommodate the result of Dotlačil and Brasoveanu (2015). We thus need to include "every night" as in (8) in the expression in (11-d). Without the VST system, we could insert the universal quantifier above the event, meaning that the nights scope over the event, as expected. However, our VST-less incremental parse, having joined all the other terms in the order in which they appeared, has "child" entity variable y scoping under the event.

(19) $\exists x \, \mathsf{caregiver}(x) \wedge \forall n \, \mathsf{night}(n) \rightarrow \exists e \, \mathsf{comfort}(e) \wedge \mathsf{OCCUR}(n, e) \wedge \mathsf{agent}(x, e) \wedge \exists y \, \mathsf{child}(y) \wedge$ $\mathsf{patient}(y, e)$

This would be acceptable when there are only existential quantifiers, as they are all logically interchangeable in scope. However, this late insertion of "night" also forces an incorrect default scope order, as well as requiring complex inference rules; the baseline order should not have a distributive meaning of "comforted" over "child". Instead, we take seriously the idea that the scopes are only computed when the event domain is complete. Then we no longer need the quantifiers to be mixed in among the predicates and can hold these bindings entirely in the VST. This has the side-benefit

of eliminating late leftward insertion:

(20) $\mathsf{caregiver}(x^{\exists}) \bullet \mathsf{comfort}(e^{\exists}) \bullet \mathsf{agent}(x, e) \bullet \mathsf{child}(y^{\exists}) \bullet \mathsf{patient}(y, e) \bullet \mathsf{night}(n^{\forall}) \bullet \mathsf{OCCUR}(n, e)$

where $\bullet \in \{\wedge, \rightarrow\}$, to be left underspecified until a final interpretation is selected based on the quantifier order.

The initial state of the VST at the end of the sentence is in (18-c). This corresponds to the order in (8-d). I repeat these here:

(21) a. The caregiver wanted the child to get some rest. ($\exists x \exists y > \forall n$)
     b.
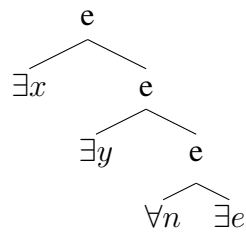
This is the baseline in Dotlačil and Brasoveanu (2015). Reaching the other interpretations provoked by the continuation sentences requires the operation *VST-move*. Application of VST-move to the *every night* variable corresponds to the following:

(22) a. The caregivers wanted the children to get some rest. ($\forall n > \exists x \exists y$)
     b.
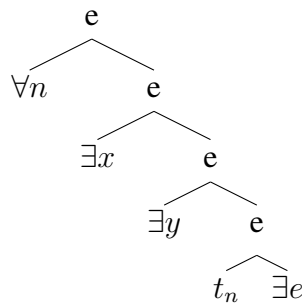
This is the dual plural reading, which has only a slightly increased probability of regression, due to the facilitation effect found by Dotlačil and Brasoveanu.

The processor VST-moves n to the highest position, so it already knows that not only one but both must have a plural reading. The more difficult readings are the plural-single readings, which are

reached *after* the first VST-move by a single additional VST-move:

(23) a. The caregivers wanted the child to get some rest. ($\forall n > \exists x$)

b.

```
              e
            /   \
         ∃y      e
               /   \
             ∀n      e
                   /   \
                 ∃x      e
                       /   \
                     t_y     e
                           /   \
                         t_n    ∃e
```
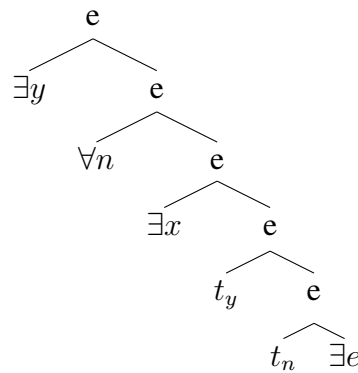
We can accommodate the plural-single reading using a similar mechanism (it has the same regression probability):

(24) a. The caregiver wanted the children to get some rest. ($\forall n > \exists y$)

b.

```
              e
            /   \
         ∃x      e
               /   \
             ∀n      e
                   /   \
                 t_x     e
                       /   \
                     ∃y      e
                           /   \
                         t_n    ∃e
```
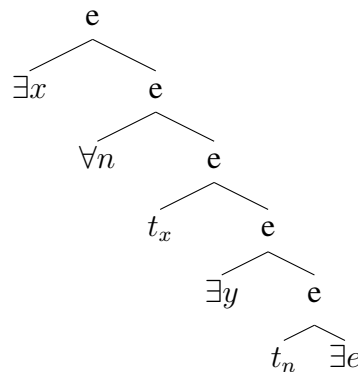
Both of these last cases are derived from the plural-plural reading – and they are both more difficult.

Repopulating the expression in (20) with quantifiers and logical operators is straightforward and can be done as necessary. This structure represents a limited degree of underspecification, without requiring the semantics to parallel a full bottom-up syntax, while leaving a structure in which the experimentally-observed reanalysis takes place.

4.1. Discouraging infinite movement

I introduce one additional behaviour of VST-move in order to discourage infinite movement, since our current definition of VST-move currently has no restriction other than the "ceiling" of an event domain; variables can be disconnected and reattached at will. I thus add the constraint that the processor disprefers achieving the same scope configuration twice.

Radó and Bott (2011) find that constructions as in (9) are strongly biased, in a judgement study, to an inverse scope reading, even though the linear scope reading remains possible for German speakers. This is reflected in their online disambiguation study, wherein subjects usually rejected the sentence early during the card sequence, if the sequence guided them to a linear scope reading. Given subjects' tendency to compute the plausible scope after the minimal domain is reached, this is consistent with a story in which the inverse scope is computed with an immediate VST-move, but then subjects resist being guided back to the original relative scope configuration. Repeating (9) here with a semantic expression:

(25) a. Genau   ein Affe   ist auf allen/jeder Karte(n) zu finden.
          Exactly one monkey is on all/each   card(s)   to find.
      b. $\mathsf{monkey}(m) \bullet \mathsf{subject}(e, m) \bullet \mathsf{location}(e, c) \bullet \mathsf{card}(c) \bullet \mathsf{find}(e)$

Which yields the following initial VST, which is essentially complete when "cards/Karten" is reached, since the rest of the sentence yields no additional variables (the root event e has already been inferred):

(26)

$$
\begin{array}{c}
e \\
\diagup\diagdown \\
1!m \qquad e \\
\diagup\diagdown \\
\exists e \quad \forall c
\end{array}
$$
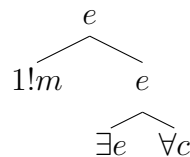
But the pragmatics seem to demand that the cards scope over the monkey. So the processor raises the scope of c:

(27)

$$
\begin{array}{c}
e \\
\diagup\diagdown \\
\forall c \qquad e \\
\diagup\diagdown \\
1!m \qquad e \\
\diagup\diagdown \\
\exists e \quad t_c
\end{array}
$$
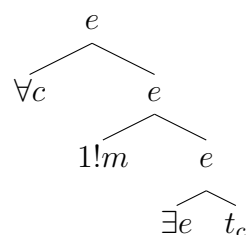
When the evidence actually forces the linear reading, the processor must raise the "exactly one monkey".

(28)

$$
\begin{array}{c}
e \\
\diagup \quad \diagdown \\
1!m \qquad e \\
\qquad \diagup \quad \diagdown \\
\qquad \forall c \qquad e \\
\qquad\qquad \diagup \quad \diagdown \\
\qquad\qquad t_m \qquad e \\
\qquad\qquad\qquad \diagup \diagdown \\
\qquad\qquad\qquad \exists e \quad t_c
\end{array}
$$
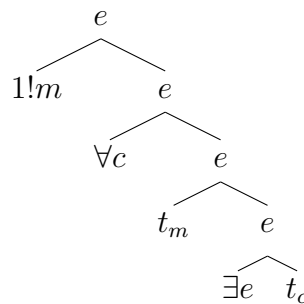
The bottom of the tree now only contains the existentially quantified event "head" variable $\exists e$ and traces. When a configuration like this exists, we see that the remainder of the tree looks like an image of (26) – that is, it has been returned to an initial state, given that sister nodes in the VST formalism are unordered. The processor highly disfavors creating a structure that contains an image of the initial VST, and so subjects tend to reject the linear interpretation. Another way of looking at this is to use the traces: at least one entity variable should not have produced a trace of VST-move for the scope structure under a given event to remain acceptable.

We would then predict that if we were to do an experiment similar to Dwivedi (2013), but with sentences that were highly lexically biased towards inverse scope, we would also see that continuation sentences that forced a linear reading would produce a significant slowdown. In other words, backing out of an already-inverse reading would be costly.

5. Conclusions and future work

In this work, I described some underlying challenges in accommodating ambiguous scope resolution in a formal incremental framework. I then combined some recent results in scope processing in order to define a model in which there are default scopes, but they are constrained by higher-order dependencies which show up as priming behaviour experimentally. Variable scope trees and VST-move allow for the highly constrained representation of possible scope configurations in a manner that replicates observations about the effort in updating scope representations; however, they are flexible enough to accommodate some variation in the underlying theory of scope processing.

There are many avenues for future work, both experimental, formal, and computational. For example, it would be possible test this system against observations about ACD and other long-distance scopal phenomena as well as to test it against scope interactions at levels other than quantifiers (e.g., negation). The latter requires a more fine-grained formal treatment of events and, potentially, discourses. This system also makes experimental predictions about the effort in scope processing, such as in reversing an already inverted scope.

One major advantage of a system like this is that the constraints imply a small derivational "horizon" at each step. That is, the number of possible VST-moves is limited both at each step in processing (since the system accommodates the possibility of pragmatically-driven ambiguity resolution before the end of the parse, if necessary) and at each step of pragmatic interpretation. Keeping a partially-underspecified representation of scope relations separate from the predicate logic is thus a further step towards constructing tractable probabilistic representations of scope ambiguity resolution and brings linguistic theory and formalism closer to computational applications.

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How many *many*s? Exploring semantic theories with data-driven computational models[1]

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Abstract. We use a data-driven computational inference approach to address the question whether it is plausible to maintain that there is a stable core semantics that governs the interpretation of cardinal and proportional *many* across different contexts. Adopting the idea that the denotation of *many* is a function of a stable threshold parameter that applies to a contextually-variable probability distribution that captures prior expectations, we demonstrate that it is possible to maintain that there is a single fixed threshold for *many*'s cardinal and proportional use, although models that allow for non-uniform thresholds or lexical ambiguity may have a slightly better empirical fit to our data.

Keywords: *many*, quantifiers, ambiguity, computational modeling, experimental data, context

1. Introduction

How do speakers use vague expressions like *many, few, tall* or *good*? What is their relation to the context and how does a learner acquire this knowledge? Assuming that language learning is economical and efficient, it is plausible that vague expressions have a stable core meaning which determines their use in any context. The opposing view would be that these words' meanings differ in each context. The second assumption makes very implausible predictions, however, namely that learners need to master the use of vague expressions anew for each context. Here, we argue for the first hypothesis and explore the relationship between vague expressions and the context.

How to capture the context-dependence of vague expressions, is a challenge to linguistic theory. In this paper, we will focus on *few* and *many*, which, similar to gradable adjectives like *tall* or *expensive*, express a number, or, in more abstract terms, a degree in a vague manner. It is hard to pin down a precise denotation in each context and there is ample variance between contexts, as exemplified in (1).

(1) a. Few of Martha's grandchildren could afford to buy a car when turning 18.
     b. Few US citizens went to the polls in the last elections.

For a long time, there has been a debate in the literature about how these expression's vagueness and their interaction with the context can be captured in their semantics (Hörmann 1983, Partee

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1989, Clark 1991, Fernando and Kamp 1996, Solt 2009). There is even dispute about how to classify them. They are labeled "quantifiers" (Barwise and Cooper 1981), "scalar quantifiers" (Hackl 2000) or "adjectives of quantity" (Solt 2009). Furthermore, some authors have questioned whether one lexical entry is sufficient: Partee (1989) proposed that *few* and *many* are ambiguous between a *cardinal* and a *proportional* reading (more below). But hardly any of these theories makes concrete predictions about which and how particular contextual parameters fix or constrain interpretation.

Previous related work (Schoeller and Franke 2015) looked at experimental data on production and interpretation of *few* and *many* and applied a data-driven computational model to investigate whether it is possible to maintain that there is a common fixed semantic core meaning that plausibly explains proportional usages across a number of diverse contexts. The idea underlying the computational model was that of Clark (1991) and Fernando and Kamp (1996): truth conditions of *few* and *many* are a function of a fixed threshold, a context-independent meaning component, on the probability density function of a distribution that captures prior expectations (more on this below). The central question of this paper is whether the findings from Schoeller and Franke (2015) extend to proportional readings of *many*.[2] Does it have a stable core meaning and is even a unified account of both readings possible? Or are we dealing with a genuine lexical ambiguity?

Section 2 introduces relevant background. Section 3 describes how we experimentally gathered data and used statistical analyses to learn about the context-sensitivity of proportional *many*. Section 4 explains how we can turn a semantic theory into a computational model of language use. Sections 5 and 6 describe more experiments to gather data which was used in computational modeling (Section 7) to see whether a unified treatment of cardinal and proportional readings is possible. By doing so, we want to contribute to the discussion about the ambiguity of *many* and the interaction between semantics and the context and follow the recent trend of combining theoretical linguistics, experimental data and computational modeling. Section 8 concludes with a methodological reflection.

2. Semantic Background

Partee (1989) argued that *few* and *many* can be read in two ways:[3]

(2)   Cardinal reading of "Few/Many As are B"
    a. Few: $|A \cap B| \leq x_{max}$ b. Many: $|A \cap B| \geq x_{min}$

(3)   Proportional reading of "Few/Many As are B"
    a. *Few*: $\frac{|A \cap B|}{|A|} \leq k_{max}$ b. *Many*: $\frac{|A \cap B|}{|A|} \geq k_{min}$

Partee (1989) suggests that the quantifiers' cardinal reading has a meaning "like that of the cardinal

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[2]We focus on *many* because we want to sidestep additional complications that seem involved in the use of *few*.

[3]Italicized A/B is the extension of predicate A/B.

numbers, *at least* x_{min}, with the vagueness located in the unspecified choice of x_{min} ... The cardinal reading of *few* is similar except that it means *at most* x_{max}, and x_{max} is generally understood to be small" (Partee 1989: p.1)[4] This theory is intuitively appealing, but the threshold parameters x_{min}, x_{max}, k_{min} and k_{max} are not specified and it is not clear how their value changes across contexts. In Schoeller and Franke (2015), we focused on the *cardinal surprise reading* as in (4) and described by Clark (1991) and Fernando and Kamp (1996).

(4) a. Joe eats many burgers. ($\rightsquigarrow$ Joe eats more burgers than expected of him.)
     b. Melanie owns many pairs of shoes. ($\rightsquigarrow$ Melanie owns more than expected of her.)

We experimentally investigated the production and interpretation of cardinal *few* and *many* and found that it is at least plausible that the relationship between the numerical denotation and the context can be captured by a fixed semantic parameter that interacts with contextually variable prior expectations (e.g., about the number of burgers a guy like Joe can be expected to eat). The semantic predictions and the model we applied are laid out in Section 4.

In this paper, we want to investigate the interaction between the context and proportional *many*. Partee (1989) discusses the proportional reading of *few* and *many* in sentences like (5) with the semantics in (3).

(5) a. Many of the US citizens live in big cities.
     b. Few of the US citizens speak German.

Sentence (5a) is true if a large proportion of US citizens live in big cities; at least k. "We may think of k either as a fraction between 0 and 1 or as a percentage" (Partee 1989: p. 2). For *few*, sentence (5d) is true if a small proportion of US citizens speaks German, at least k. How to define the size of the fraction k which determines of usage of *few* and *many* is left unspecified, however. Furthermore, (3) does not tell us what the influence of the context on threshold k is or whether it is assumed to be a fixed proportion. In an experiment on the interpretation of proportional *many*, we want to find out whether it is possible to define k independently of the context.

3. Experiment: Influence of the context on the interpretation of proportional *many*

In this experiment on the interpretation of sentences with proportional *many*, we want to investigate the influence of the contextual expectations. Furthermore, we want to find out whether it makes a difference to use *many* in the plain form "many" or in the partitive construction "many of the" and whether the number of objects in the context influences the interpretation.

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[4]Partee (1989) labels both variables with n. For consistency with the theory proposed in Section 2 we use x_{max} and x_{min} instead.

3.1. Methods and material

We ran an experiment on Amazon's Mechanical Turk and elicited data from 160 participants for a reimbursement of 0.50$. Participants who are not self-reported native speakers of English or showed clearly uncooperative behaviour were excluded. At the beginning of the experiment, each participant was randomly assigned to condition [-/+ partitive]. [-partitive] means, that every sentence was presented with plain "many", whereas in the [+partitive] condition "many of the" was used. Every participant saw 16 items. A sentence introduced the context and the amount of the objects under discussion. Each item was paired with two numbers of the form {N, 3/4N} and one of these numbers was randomly chosen in each trial as the total amount. A sentence containing the quantifier was randomly chosen from two conditions [HP/LP], high probability or low probability. The two conditions differed in the comparison class set in the relative clause. We set the comparison classes in a way that we expect higher answers in high probability contexts. We made sure that the two relative clauses per item are a minimal pair. Most of them differed only in contrasting adjectives. A sample item is given in (6) and (7). In a free production task, participants were asked to guess the number that they think "many" or "many of the" refers to.

(6) There were **9/12** muffins on the kitchen table in Eds flat.

  HP: Ed, who arrived feeling hungry, ate **many/many of the** muffins.

  LP: Ed, who arrived feeling full, ate **many/many of the** muffins.

  How **many/many of the** muffins do you think Ed ate?

(7) When moving flat, Martha packed **15/20** big boxes.

  HP: Martha, who is a strong woman, carried **many/many of the** boxes herself.

  LP: Martha, who is a weak woman, carried **many/many of the** boxes herself.

  How **many/many of the** boxes do you think Martha carried?

3.2. Hypotheses

We expect that the comparison class has an effect on the interpretation of "many". We expect that people interpret *many* as higher numbers / proportions in the high probability condition than in the low probability condition. The partitive construction should facilitate a proportional reading. This is why we expect less of an influence of the comparison class in sentences with "many of the". The difference between low and high probability should not be as big as for the sentences with plain "many". Furthermore, a pre-study suggests that the number of objects in the context influences the interpretation of "many". We expect that if the number is high, it is more likely that the proportional interpretation is lower than if participants are presented with a low number of objects. However, as the range of amount is not very big in this experiment, it would not be surprising to find no effect of amount.

Condition	Mean proportion
plain & low	0.58
plain & high	0.73
partitive & low	0.58
partitive & high	0.67
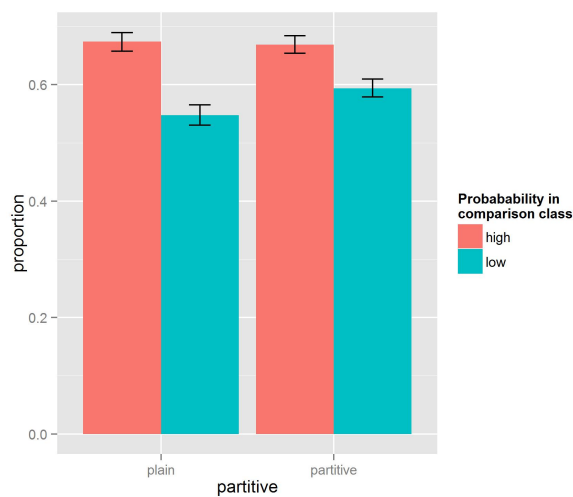
Figure 1: Mean ratings for the interpretation of *many* in proportions of *N* for both high and low probability contexts and without or with the partitive construction

3.3. Results

Figure 1 gives a first impression of the outcome of the experiment. When looking at the mean proportions of *N* that were given as the interpretation of *many*, we see a clear difference between LP and HP condition. This is a first piece of evidence which supports the hypothesis that prior expectations influence interpretation. Furthermore, the difference between low and high probability is greater in the plain condition than when the partitive is used. Whether these differences are statistically significant will be analyzed in the following.

At first we specified a mixed linear effects regression model predicting proportional interpretations for "many" which included the main effects "level" (high or low probability sentence), "amount" (number in context), "partitive" (plain or partitive "many") and an interaction of these three predictors. In terms of random effects, the initial model had the maximal random effects structure as justified by the design (Bates et al. 2013). We removed redundant random effects by running a principle component analysis and arrived at a parsimonious model (Bates et al. 2015). The final model included both varying intercepts for "participant" and "item", as well as a random "participant" slope for "level". In terms of the fixed effects, only "level" was included as a main effect. We found that participants gave significantly lower ratings in the low-level condition ($\beta = -0.128, SE = 0.013, p < 0.001$). Figure 2a shows the predicted interpretation of *many* in proportions of *N* in both HP and LP condition of the factor "level". The data suggests that participants interpret *many* as a lower proportion of *N* when it is presented in a low probability context than when *many* occurs in a high probability context. We can interpret the fact that the factor "level" was identified as a main effect as evidence that the context influences the interpretation of proportional *many*. This effect was modulated by an interaction of "level" with "partitive"
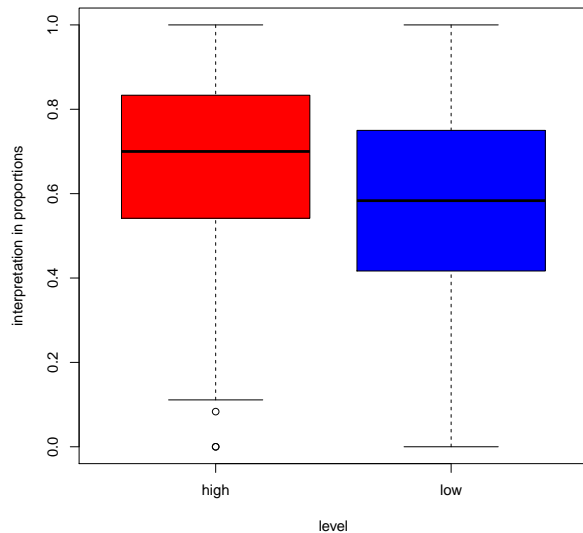
(a) Main effect of level
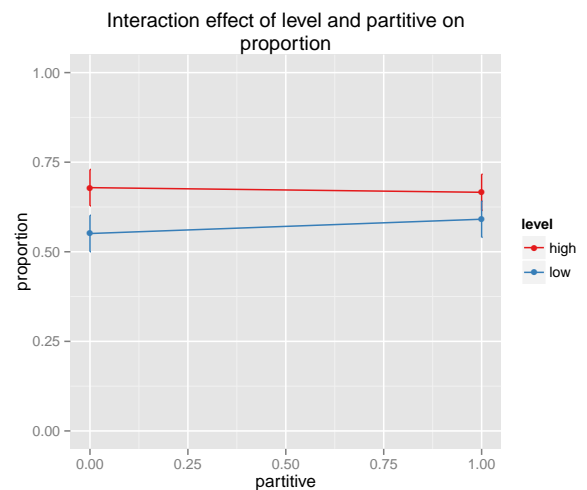
(b) Interaction between level and partitive

Figure 2: Differences in proportional ratings between high and low probability contexts and with (partitive = 1) or without (partitive = 0) partitive construction.

($\beta = -0.052, SE = 0.018, p < 0.005$). Figure 2b shows again that ratings are lower in the low-level condition, for both forms of the quantifier. However, in the low-level condition the partitive construction (x-axis: partitive = 1) triggers higher ratings than plain "many" (x-axis: partitive = 0). This slope is reversed in the high-level condition. The plot shows that the factor "partitive" has an effect on the interpretation of *many* in that it interacts with "level". However, the plot also shows that "partitive" is not a strong enough fixed factor to qualify as a main effect. In Subsection 3.2 we hypothesized that the partitive construction should facilitate a proportional reading and allow less of a difference between the two context conditions. Figure 2b displays that the difference between low and high probability contexts is slightly bigger in sentences without a partitive but that the difference to sentences with a partitive construction is not significant.

3.4. Discussion

The linear mixed effects regression suggests that the comparison class has a significant effect on the interpretation of *many*. This contradicts a theory which assumes one fixed value for the proportion *k*. Rather, the semantics should comprise *many*'s interaction with the context. Interestingly, neither the factor "amount" nor the factor "partitive" were significant. That the use of these two factors does not make a difference leaves open the possibility of a unified semantics because cardinal *many* cannot be combined with the partitive nor is its range restricted by an upper bound.

As a next step, we want to examine more closely how the interpretation of proportional *many* is affected by the context. To do this, we want to measure people's prior expectations of typical amounts in the contexts we used and apply a computational model to our data which formalizes a particular way of mapping these contextual expectations onto predictions about language use. The next section introduces this model.

4. CFK semantics and computational modeling

A concrete proposal of how contextual expectations map onto truth conditions of *many* and *few*, was first suggested tentatively by Clark (1991) and formally spelled out by Fernando and Kamp (1996). We will call it the Clark-Fernando-Kamp (CFK) semantics. The CFK semantics describes the reading of *few* and *many* in sentences like (8) as the cardinal surprise reading because it treats it as intensional and expresses that the number in question is lower or higher than expected.

(8)   Melanie owns few/many pairs of shoes.

(9)   **CFK Semantics**

        a. $[[\text{Few } A \text{ are } B]] = 1$ iff $|A \cap B| \leq x_{max}$

$$\text{where } x_{max} = \max\{n \in \mathbb{N} \mid P(|A \cap B| \leq n) < \theta_{few}\}$$

        b. $[[\text{Many } A \text{ are } B]]$ iff $|A \cap B| \geq x_{min}$

$$\text{where } x_{min} = \min\{n \in \mathbb{N} \mid P(|A \cap B| \leq n) > \theta_{many}\}$$

The CFK semantics in (9) aims to explain the contextually variable thresholds x_{max} and x_{min} from the truth-conditions in (2) as a function of prior expectations P and a pair of fixed thresholds θ_{few} and θ_{many} on the cumulative distribution derived from P. Thresholds θ_{few} and θ_{many} can then be conceived of as the contextually-stable semantic core meaning of *many* and *few* that would help explain how vague quantifiers can be meaningfully used and faithfully acquired. Applied to example (8), given (9b) the sentence is true if the number of shoes owned by Melanie is greater than x_{min}. In turn, x_{min} is specified as the lowest number for which the cumulative density mass of the prior expectation P over numbers of shoes that Melanie owns is higher than the semantically fixed threshold θ_{many}.

The CFK semantics looks intuitively appealing, but how can such a proposal even be tested? Toward this end, we look at a computational model. The idea is that we use empirical measures of expectations P (for each relevant context) and feed it into the model. The model then predicts threshold values via (9) and maps these onto a likelihood of judging a statement with *few* or *many* as true in a particular context and a likelihood of interpreting it in a particular way. (see Schoeller and Franke 2015: for details). Here, we focus on the interpretation of *many*.

Data from experiments on the interpretation of *many* is used to "reverse infer" credible values for the threshold θ_{many} by Bayesian inference. Concretely, we compare models in which we infer just

one treshold θ_{many} that applies to all contexts with an alternative model that uses an independent θ_{many} for every context. The question which model better fits the data can then be addressed by statistical model comparison. This fuels the discussion of the theoretical question whether the CFK semantics as a whole and belief in a uniform θ_{many} in particular are plausible assumptions.

5. Experiment: Prior elicitation for proportional *many*

This experiment was designed to gather data about people's prior expectations concerning the contexts used in the interpretation task from Section 3.

5.1. Methods and material

We ran the experiment on Amazon's Mechanical Turk and elicited data from 160 participants for a reimbursement of 0.35$. Only data by native speakers of English was considered. We designed the material in a way that ensured compatibility with the interpretation task. Because the analysis of the interpretation data did not support a significant main effect of the partitive construction (*many* vs. *many of the*) or of number (the number of objects or activities presented), we decided to not further investigate these two factors. However, we included the factor level (low or high probability of the event) because we found that this was a main effect. We only elicited prior expectations of 10 of the previous 16 items. Each item contained a fixed number of objects or activities. Depending on the number introduced in the item, we presented participants with 10, 13 or 16 intervals and asked to rate the probability of this number by adjusting a slider on a scale ranging from "very unlikely" to "extremely likely". Two sample items are given below, the remainder in Appendix A:

(10)   There were 12 muffins on the kitchen table in Eds flat.

   HP: Ed arrived feeling hungry.

   LP: Ed arrived feeling full.

   How many of the muffins do you think Ed ate?
   {0,1,2,3,4,5,6,7,8,9,10,11,12}

(11)   When moving flat, Martha packed 15 big boxes.

   HP: Martha is a strong woman.

   LP: Martha is a weak woman.

   How many of the boxes do you think Martha carried?
   {0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15}

5.2. Hypotheses

In the interpretation task we found that the comparison class (e.g., a hungry vs. full person eating muffins) had an effect on the interpretation of *many*. Furthermore, our previous research suggests that for cardinal *few* and *many* production and interpretation can be predicted by a context-independent threshold, which can be formalized as a percentage on the cumulative density mass of the prior expectation (Schoeller and Franke 2015). The findings in Section 3 suggest that it might be plausible to find such a context-independent threshold for the interpretation of proportional *many*, too. Whether the actual percentage of the cumulative density mass of the prior is the same as for cardinal *many* remains to be seen.

5.3. Results

Figure 3 displays the probability distributions we measured and which we take to represent the prior expectations. We first normalized the ratings of each item within participants. Second, we calculated the mean rating of each interval for all participants. These probability distributions are input to the computational model which estimates context-independent threshold values if the data suggests that they exist.

6. Experiment: Cardinal *many*

As a sanity check of the findings in Schoeller and Franke (2015), we reran the experiments on production and interpretation of cardinal *few* and *many* and also elicited prior expectation of the presented contexts. The design remained unchanged (see Schoeller and Franke (2015) for a detailed description), but we replaced some items for which the context or the phrasing was unclear. This data will be used in Section 7 when a computational model is applied to data from both cardinal and proportional uses of *many*. The items can be found in Appendix B.

7. Computational models

The CFK semantics' predictions were transformed into a probabilistic computational model of interpretation behavior. Latent semantic parameters, in this case the threshold values θ_{few} and θ_{many}, are estimated on the basis of the experimental data (see Section 4). To ensure comparability, we estimated the parameters based on interpretation data only.

We will run two or three versions of the model for each data set. The first version follows the predictions of the CFK semantics and estimates **one** threshold value θ_{many} which explains the interpretation of *many* for each item. We call it the general threshold model (**GTM**). The second version captures the alternative hypothesis that there need not be a universally shared threshold. Consequently, we allow for an **individual** threshold parameter for each context. This model is called individual threshold model (**ITM**). It is likely that the ITM yields a good fit to the data;
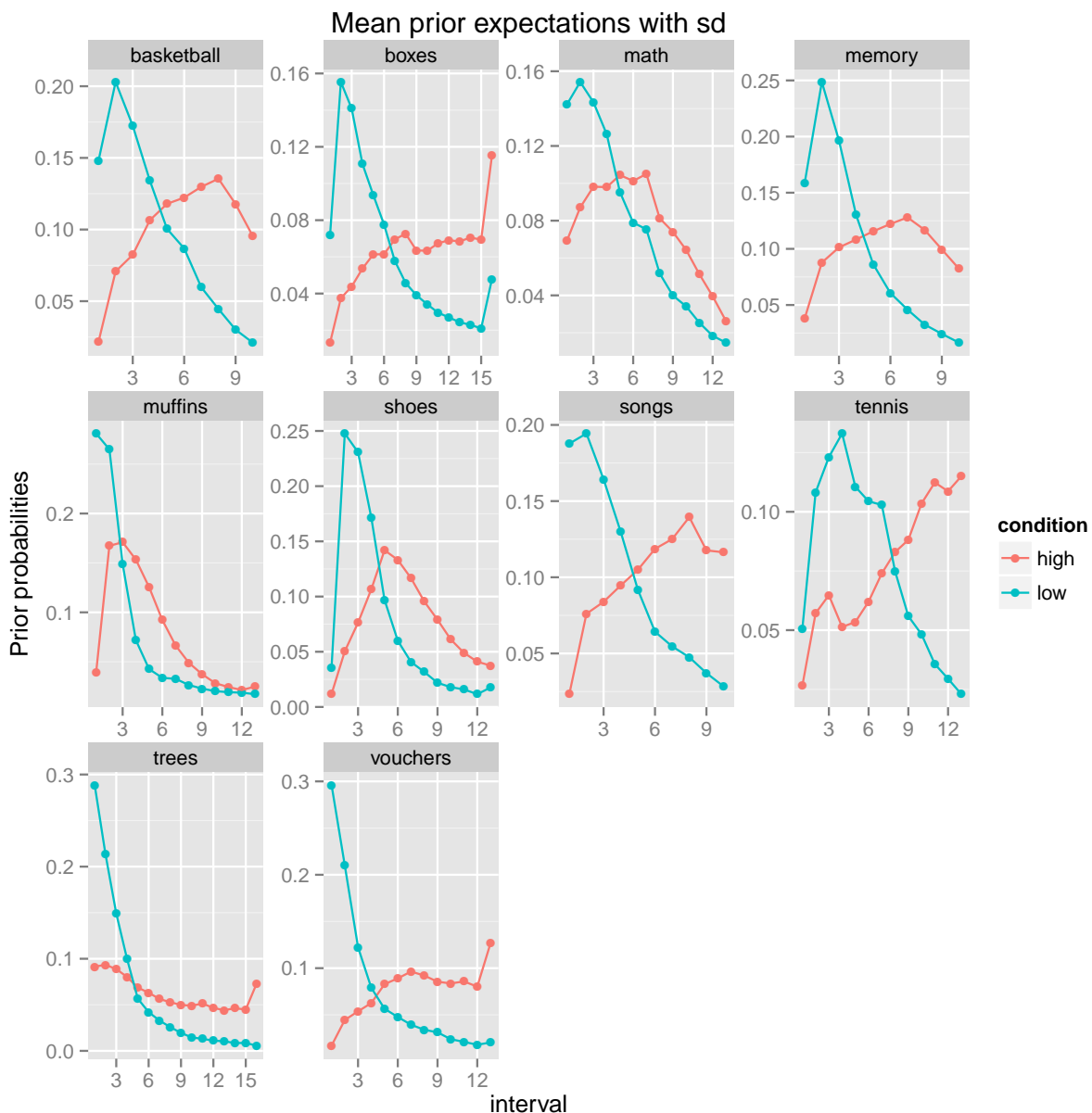
Figure 3: Proportional *many*, prior expectations for both context conditions

however, this flexibility comes at a price: it is much more complex because it is forced to estimate one parameter per context and not one for each of them as the GTM does. The third version of the model, the **threshold per reading** model (**TRM**) tests the hypothesis that *few* and *many* are lexically ambiguous. It is based on the assumption that both readings are captured by the CFK semantics but that their threshold values are different. We will compare the three versions' fit to the data in a statistical model comparison using each model's DIC value. This concept combines a measure of model fit with a measure of model complexity and will be introduced and applied in

Section 7.5. For each version of the model and each data set, we collected 10,000 samples from 2 MCMC chains after a burn-in of 10,000. This ensured convergence for every model, as measured by $\hat{R}$.

For each context, we are not only interested in its DIC value, but also in the variance of the individual thresholds. To check whether these individual thresholds are similar, we will estimate 95% credible intervals for the marginalized posteriors over each threshold in the ITM. A 95% credible interval is, intuitively put, an interval of values that are sufficiently plausible to warrant belief in (see Kruschke 2014). For example, if [0.65;0.75] were the 95% credible interval for θ^i_{many} for some item i, we should be reasonably certain that the true value of θ^i_{many} is in this interval. If the contexts credible parameter values for θ^i_{many} overlap on some interval, this interval is where a uniform semantic threshold might reside.

7.1. Hypothesis:

We expect that the model comparison favors the GTM because it predicts that the denotation of *many* is calculated in the same way for each context. This way, the vagueness of the expression is preserved because its denotation is still dependent on the contextual input, but the procedure is fixed. Most importantly, this is what we expect from the perspective of processing and language learning. We can interpret *many* in infinitely many contexts justs as we are able to understand an infinite number of sentences by compositionality.

7.2. Proportional *many* (20 contexts)

General θ model: The mean of the posterior of θ_{many} was estimated via sampling as 0.83. This model has a DIC = 977.9 and pD = 24.7.

Individual θs model: In total, 12 of 20 thresholds' HDIs overlapped in 0.83, among them 8 contexts in the low probability conditions (see Figure 4). DIC = 889.2 and pD = 55.9.

7.3. Cardinal *many* (14 contexts)

General θ model: The mean of the posterior of θ_{many} was estimated via sampling as 0.69. DIC = 1076.3 and pD = 19.2.

Individual θs model: For cardinal *many*, 7 of 14 items' HDIs overlap in [0.65, 0.70] which includes $\theta_{many} = 0.69$ estimated by the GTM (see Figure 5). DIC = 995.0 and pD = 42.7.
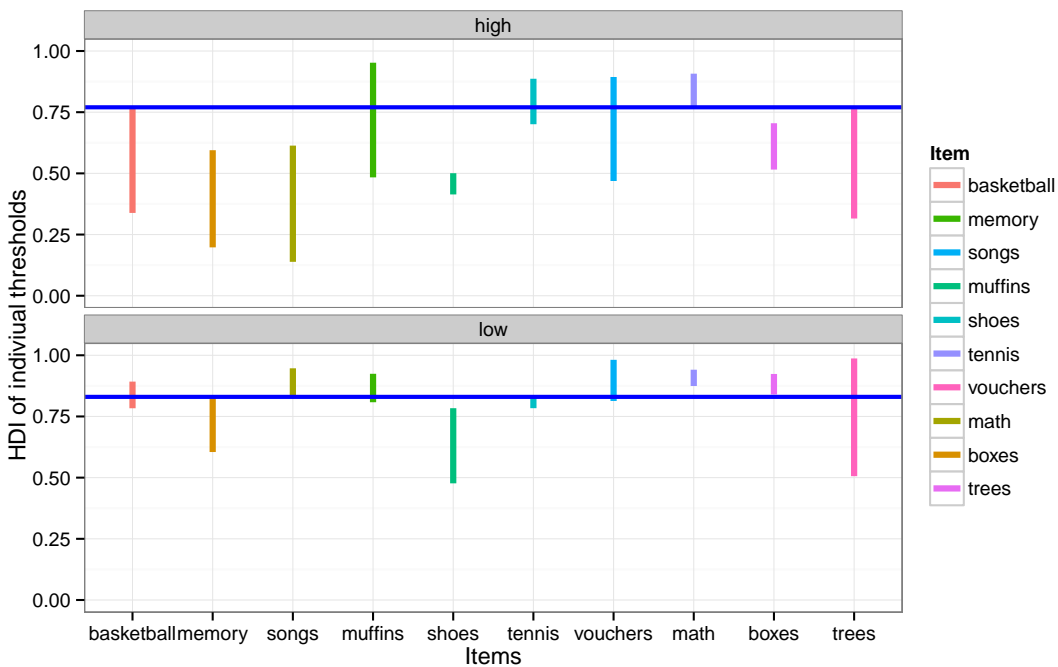
Figure 4: Proportional *many*: posteriors of individual threshold values in both conditions

7.4. Fusing cardinal and proportional readings (34 contexts)
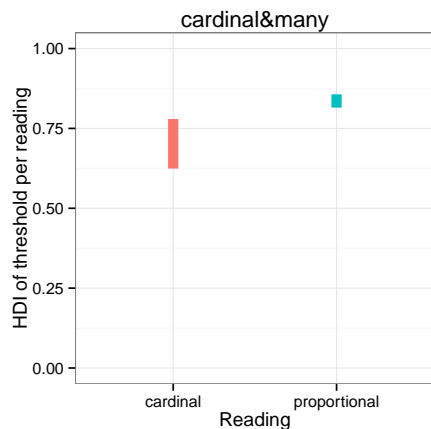
Figure 6: threshold values for cardinal and proportional reading in TRM

General θ model: This model tests whether it is possible to find one threshold which explains both readings of *many* at once. The mean of the posterior of θ_{many} was estimated via sampling as $\theta_{many} = 0.83$. (Note: that the value for a general θ_{many} is this high is very likely based in the fact that 20 of the 34 contexts are proportional, compare Subsections 7.2 and 7.3). DIC = 2061.0 and pD = 39.7.

θ **per reading model**: This model estimates one threshold per readings. $\theta_{many:prop}$ captures all interpretations of proportional *many* and $\theta_{many:card}$ all interpretations of cardinal *many*. The HDI of the threshold for the proportional uses of *many* is $\theta_{many:prop}$ = [0.82, 0.86] and for the cardinal uses $\theta_{many:card}$ = [0.62, 0.78] (see Figure 6). DIC = 2056.4 and pD = 45.7.
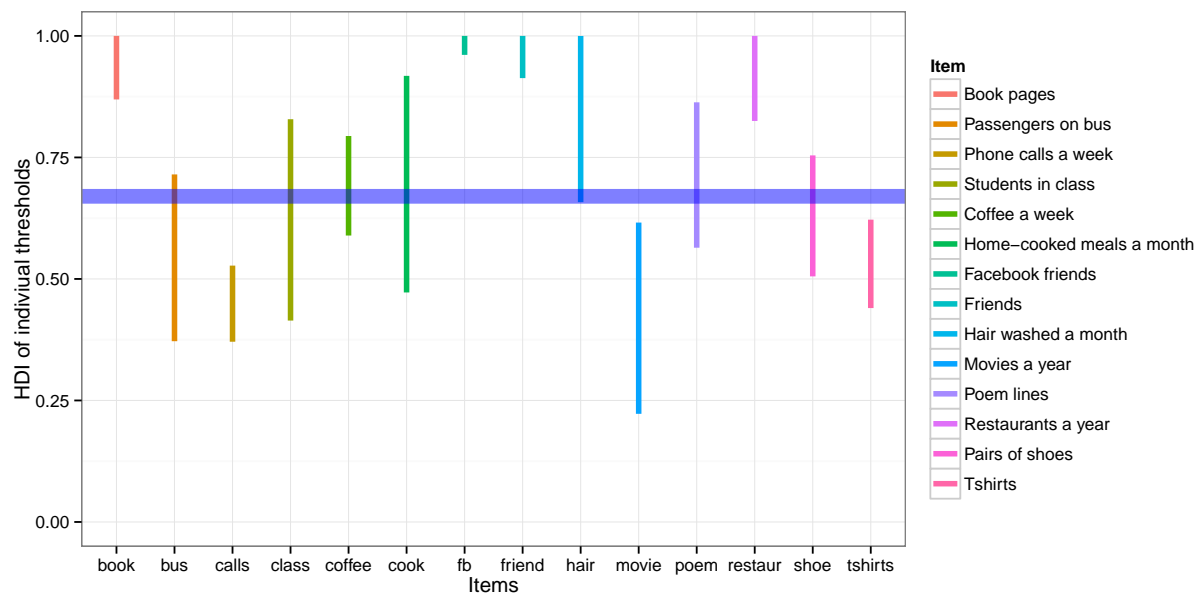
Figure 5: Cardinal *many*: predictions for individual thresholds

Individual θs model: In total, 17 of the 34 thresholds' HDIs overlapped in the GTM's posterior mean for θ_{many}, which was 0.83. Most of these contexts contained proportional *many*. 12 out of the 20 proportional contexts' HDIs overlapped in 0.83, among them 8 in the low probability condition. For cardinal *many*, 8 out of 14 items' thresholds overlapped in the interval [0.58, 0.59] and 7 out of 14 overlap in [0.66, 0.72] (see Figure 7). DIC = 1881.0 and pD = 96.4.

7.5. Model comparison

We want to test the hypothesis by choosing the model with the best trade-off between complexity and fit to the data. To decide on the best of all converging models, we apply a Bayesian model-choice method called deviance information criterion (DIC) which was introduced in Spiegelhalter et al. (2002). This is "a Bayesian analogue of classical model-choice criteria, such as the Akaike information criterion (AIC). DIC combines a measure of model fit - the expected deviance - with a measure of model complexity - the effective number of parameters" (Plummer 2008). This criterion is particularly suitable for the method we apply since it is simple to calculate using Markov chain Monte Carlo (MCMC) simulation and is already implemented in the program JAGS (Plummer 2010). The DIC is widely used in Bayesian statistics (cf. Plummer 2008). A high value of the DIC indicates a lot of deviance of the model's predictions from the data it is applied to. This is undesirable, of course. At the same time, the model should stay as concise as possible and not include unnecessary parameters. This is measured by the *pD*, the effective number of parameters, a measure of model complexity. The higher the pD, the more free parameters.
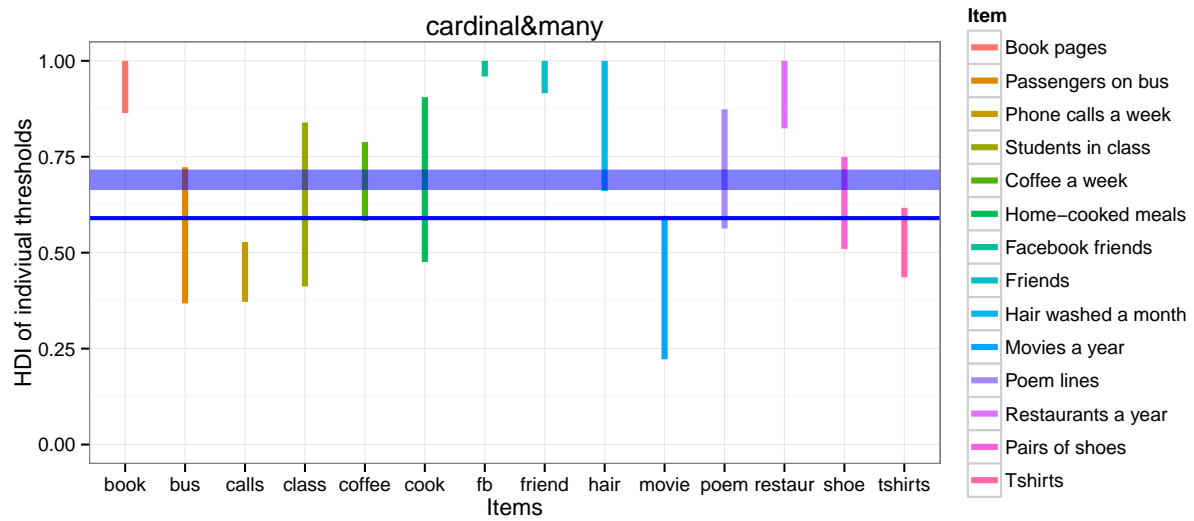
(a) HDIs of threshold values for cardinal *many*
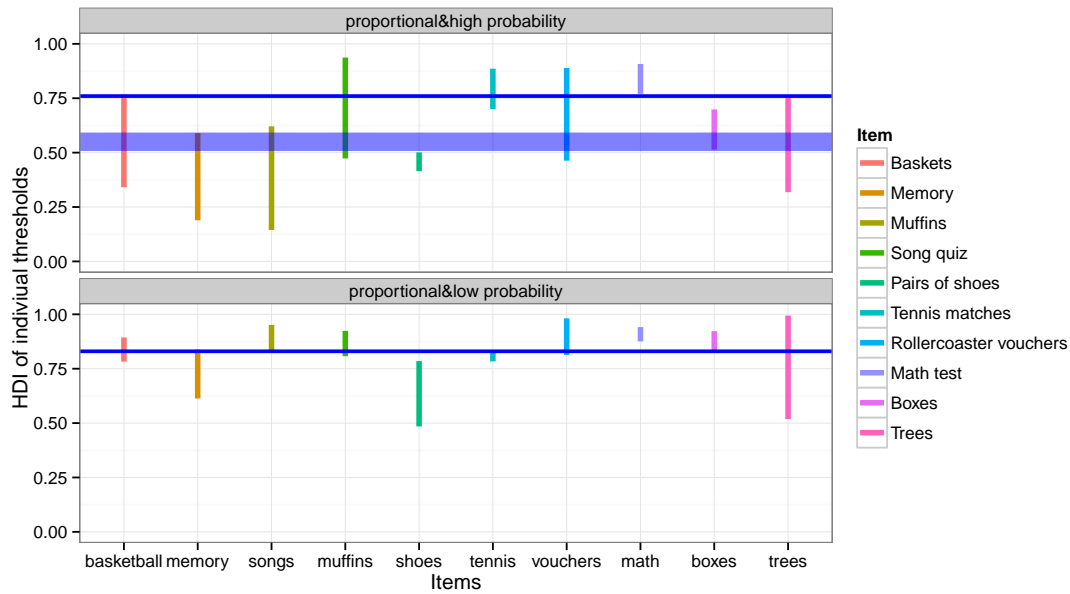
(b) HDIs of threshold values for proportional *many* in high and low probability condition

Figure 7: Model for both cardinal and proportional *many*

data set	GTM	ITM	TRM	deviance GTM from ITM	GTM from TRM
proportional	977	889		10%	
cardinal	1076	995		8 %	
proportional & cardinal	2061	1881	2056	10%	0.002%

A comparison of the models' DIC states that, for each data set, the ITM yields the best fit to the

data. However, the difference between the DIC values of ITM and GTM is very small. For each data set the difference is not higher than 10%. For the data set of proportional and cardinal items, there is basically no difference between the GTM and TRM. Furthermore, we find that the HDIs of the individual thresholds differ slightly for each model. We could not find one θ which predicts the participants' behavior for each context.

8. Discussion

Statistically, the outcome of the model comparison leaves no doubt. Even though the individual threshold models are much more complex, their fit to the data is the better than the other two models'. Furthermore, for none of the three ITMs did the individual items' thresholds overlap in one interval. This seems to contradict our tentative suggestion of a unified semantics of *many* which successfully predicts the interpretation of *many* in every context or at least uniformly in each reading. Nevertheless, for all three data sets the difference in the DIC value between the three versions of the model was small. This encourages us not to dismiss of the idea of one context-independent parameter in the semantics of *many* too easily. Our findings suggest that there is an interaction with context.

The model comparison shows that allowing individual thresholds results in a better fit to the data. However, the models containing one or two general thresholds are not much worse in their fit and in predicting the measured interpretations. And we also have to keep in mind that choosing one model over the other in terms of fit to the data does not come without a cost. If we only focus on this factor, we might have to accept models which are extremely complex and this contradicts our understanding of language learning. Even though the individual-threshold models can explain the experimental data better, they are much more complex because they include one extra parameter per item. Our data set was very restricted so that each model only had to account for data from 10 to 34 contexts. This is not what a learner of a language who encounters vague expressions has to face. Her data set is substantially larger. If we assumed that a learner tried to figure out a threshold - and consequently a new meaning for *many* - for each of these numerous contexts, we would also assume that such a model would become increasingly and arbitrarily complex. This cannot be a reasonable prediction of how language learning works. So even if the ITM results in a slightly better fit to the data set, we have to keep in mind that this set is very restricted and that the predictions this model makes are not what we assume of the data set a learner faces in reality.

We also want to point out that the model we proposed is very basic and only takes into account the listener's behavior. Since the model does not predict production behavior, it ignores the fact that a listener reasons about why a speaker chose a certain word to express the meaning she wants to convey. Furthermore, the model is a semantic model, not a pragmatic one. It does not take into account alternative utterances and their complexity. These factors are only some examples from a large list of possibilities of how the model could be developed and extended. Another exciting option would be to apply it to other vague expressions like gradable adjectives.

Another interesting finding of the present approach is that it suggests different thresholds for proportional and cardinal uses of *many*. The threshold for cardinal *many* estimated at 0.69% of the cumulative density mass seems to be lower than for proportional *many* (0.83%). These values seem reliable because they were reproduced by the TRM. Nevertheless, the difference in terms of fit to the data between GTM and TRM was vanishingly small. Further research is needed to see whether, by looking at production data as well, a uniform threshold-hypothesis could be maintained after all.

A. Proportional *many*, interpretation study

1. **basketball** — Alex took part in a basketball competition and was allowed 9/12 shots from the three-point line. — HIGH: Alex, who is a professional player, made many (of the) shots. — LOW: Alex, who is an amateur player, made many (of the) shots. — How many (of the) shots do you think Alex made?

2. **memory** — For a memory test 9/12 three-digit numbers were read out to Chris. — HIGH: Chris, who has a great memory, memorized many (of the) numbers. — LOW: Chris, who has a bad memory, memorized many (of the) numbers. — How many (of the) numbers do you think Chris memorized?

3. **songs** — In a music quiz the beginnings of 9/12 pop songs were played. — HIGH: Heidi, who loves pop songs, recognized many (of the) songs. — LOW: Heidi, who hates pop songs, recognized many (of the) songs. — How many (of the) songs do you think Heidi recognized?

4. **muffins** — There were 9/12 muffins on the kitchen table in Ed's flat. — HIGH: Ed, who arrived feeling hungry, ate many (of the) muffins. — LOW: Ed, who arrived feeling full, ate many (of the) muffins. — How many (of the) muffins do you think Ed ate?

5. **shoes** — Melanie had to choose which among 9/12 pairs of shoes to bring on holiday. — HIGH: Melanie, who loves fashion, packed many (of the) pairs of shoes. — LOW: Melanie, who doesn't care about fashion, packed many (of the) pairs of shoes. — How many (of the) pairs of shoes do you think Melanie packed?

6. **tennis** — Bruno played 12/16 tennis matches last season. — HIGH: Bruno, who is an unathletic person, lost many (of the) matches. — LOW: Bruno, who is a fit person, lost many (of the) matches. — How many (of the) matches do you think Bruno lost?

7. **vouchers** — Carla won 9/12 vouchers for roller coaster rides on a fair. — HIGH: Carla, who is an adventurous person, used many (of the) vouchers. — LOW: Carla, who is a fearful person, used many (of the) vouchers. — How many (of the) vouchers do you think Carla used?

8. **math** — A math teacher presented a tricky problem to the 18/24 students in his course. — HIGH: Many (of the) students in his course, which focuses on problem-solving strategies, could solve the problem. — LOW: Many (of the) students in his course, which does not teach problem-solving strategies, could solve the problem. How many (of the) students do you think could solve the problem?

9. **boxes** — When moving to a new flat, Martha packed 15/20 boxes. — HIGH: Martha, who is a strong woman, carried many (of the) boxes herself. — LOW: Martha, who is a weak woman, carried many (of the) boxes herself. — How many (of the)boxes do you think Martha carried?

10. **trees** — Jim had 15/20 trees in his garden. — HIGH: Jim, who is a strong man, cut down many (of the) trees. — LOW: Jim, who is a weak man, cut down many (of the) trees. — How many (of the) trees do you think Jim cut down?

B. Cardinal *many*, prior elicitation and interpretation study

1. **book** — A friends favorite book has been published only recently (and has few/many pages). — How many pages do you think the book has? — intervals: 0-40, 41-80, 81-120, 121-160, 161-200, 201-240, 241-280, 281-320, 321-360, 361-400, 401-440, 441-480, 481-520, 521-560, 560 or more

2. **movie** — Nick is a man from the US (who saw few/many movies last year). — How many movies do you think Nick saw last year? — intervals: 0-2, 3-5, 6-8, 9-11, 12-14, 15-17, 18-20, 21-23, 24-26, 27-29, 30-32, 33-35, 36-38, 39-41, 42 or more

3. **poem** — A friend wants to read you her favorite poem (which has few/many lines). — How many lines do you think the poem has? — intervals: 0-3, 4-7, 8-11, 12-15, 16-19, 20-23, 24-27, 28-31, 32-35, 36-39, 40-43, 44-47, 48-51, 52-55, 56 or more

4. **burger** — Joseph is a man from the US (who ate few/many burgers last month). — How many burgers do you think Joseph ate last month? — intervals: 0-1, 2-3, 4-5, 6-7, 8-9, 10-11, 12-13, 14-15, 16-17, 18-19, 20-21, 22-23, 24-25, 26-27, 28 or more

5. **shoes** — Melanie is a woman from the US (who owns few/many pairs of shoes). — How many pairs of shoes do you think Melanie owns? — intervals: 0-2, 3-5, 6-8, 9-11, 12-14, 15-17, 18-20, 21-23, 24-26, 27-29, 30-32, 33-35, 36-38, 39-41, 42 or more

6. **bus** — Vehicle No. 102 is a school bus (which has seats for few/many passengers). — How many passengers do you think can sit in Vehicle No. 102? — intervals: 0-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70 or more

7. **class** — Erin is a first grade student in primary school. (There are few/many children in Erins class.) — How many children do you think are in Erins class? — intervals: 0-2, 3-5, 6-8, 9-11, 12-14, 15-17, 18-20, 21-23, 24-26, 27-29, 30-32, 33-35, 36-38, 39-41, 42 or more

8. **hair** — Betty is a woman from the US (who washed her hair few/many times last month). — How many times do you think Betty washed her hair last month? — intervals: 0-2, 3-5, 6-8, 9-11, 12-14, 15-17, 18-20, 21-23, 24-26, 27-29, 30-32, 33-35, 36-38, 39-41, 42 or more

9. **friends** — Lelia is a woman from the US (who has few/many friends). — How many friends do you think Lelia has? — intervals: 0-1, 2-3, 4-5, 6-7, 8-9, 10-11, 12-13, 14-15, 16-17, 18-19, 20-21, 22-23, 24-25, 26-27, 28 or more

10. **cook** — Tony is a man from the US (who cooked himself few/many meals at home last month). — How many meals do you think Tony cooked himself at home last month? — intervals: 0-3, 4-7, 8-11, 12-15, 16-19, 20-23, 24-27, 28-31, 32-35, 36-39, 40-43, 44-47, 48-51, 52-55, 56 or more

11. **tshirts** — Liam is a man from the US (who has few/many T-shirts). — How many T-shirts do you think Liam has? — intervals: 0-2, 3-5, 6-8, 9-11, 12-14, 15-17, 18-20, 21-23, 24-26, 27-29, 30-32, 33-35, 36-38, 39-41, 42 or more

12. **facebook** — Judith is a woman from the US (who has few/many Facebook friends). — How many Facebook friends do you think Judith has? — intervals: 0-69, 70-139, 140-209, 210-279, 280-349, 350-419, 420-489, 490-559, 560-629, 630-699, 700-769, 770-839, 840-909, 910-979, 980 or more

13. **coffee** — Andy is man from the US (who drank few/many cups of coffee last week). — How many cups of coffee do you think Andy drank last week? — intervals: 0-1, 2-3, 4-5, 6-7, 8-9, 10-11, 12-13, 14-15, 16-17, 18-19, 20-21, 22-23, 24-25, 26-27, 28 or more

14. **calls** — Lisa is a woman from the US (who made few/many phone calls last week). — How many phone calls do you think Lisa made last week? — intervals: 0-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70 or more

15. **restaurants** — Sarah is a woman from the US (who went to few/many restaurants last year). — To how many restaurants do you think Sarah went last year? — intervals: 0-3, 4-7, 8-11, 12-15, 16-19, 20-23, 24-27, 28-31, 32-35, 36-39, 40-43, 44-47, 48-51, 52-55, 56 or more

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On pragmatic demonstratives:
The case of pragmatic discourse anaphora in Czech[1]
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Abstract. This paper offers a novel syntactico-semantic treatment of canonical and pragmatic demonstratives (the latter type being exemplified by so called affective demonstratives) and within that frame provides an analysis of pragmatic anaphora in Czech. Pragmatic anaphora is understood as an anaphoric relation between the denotation of a demonstrative description and a previous utterance about that denotation. The theoretical proposal is that the syntactic and semantic structure of demonstratives consists of two parts: the D head, interpreted as the iota type shifter (i.e., as a Fregean definite article), and the Dem head, which conveys that the denotation of its nominal complement is related to some entity in extra-linguistic reality or discourse. Due to nanosyntactic principles (superset and elsewhere), demonstratives can either spell out the whole Dem+D structure (canonical demonstratives) or Dem alone (pragmatic demonstratives).

1. Introduction

Demonstratives (DEM) typically have a clear semantic contribution: they shift the property denoted by their NP complement to the single individual in its extension (relative to some situation), see (1). On this Fregean view, demonstratives are definite articles of sorts: even if their semantic contribution is more complex, they always have something like (1) at their core (Wolter, 2006; Elbourne, 2008). Examples of these, what I will call *canonical demonstratives* (whence DEM_{can}) are provided in (1-a) (deictic use) and in (1-b) (an anphoric use).

(1)   **Canonical demonstratives**
        $[[\text{DEM}_{can} \ NP_{\langle e,st \rangle}]] = \iota x[[NP]](x)(s)$ (for some situation s)
        a.   Look at that/this ($\approx$ the) man [GESTURE AT SOME MAN].
        b.   We met Senator Johnson. This ($\approx$ The) politician has been in office since 2011.

There are demonstratives, called here *pragmatic demonstratives* (DEM_{prag}), which defy this simple view because they do not change the core semantics of their NP complement: proper names remain proper names (2-a), generics remain generics (2-b), and indefinites remain indefinites (2-c).

(2)   **Pragmatic demonstratives**
        $[[\text{DEM}_{prag} \ NP]] = [[NP]]$
        a.   This ($\not\approx$ The) Henry Kissinger is really something!   (Lakoff, 1974: 347)

b.   Those ($\napprox$ The) IBM ThinkPads are quite popular.   (Bowdle and Ward, 1995: 33)
c.   …there was this ($\napprox$ the) hippie, long-haired, slovenly.   (Prince, 1981: 233)

The present paper sets out to achieve two goals – an empirical and a theoretical one. On the empirical side, I will present data from Czech (novel in the formal literature), where pragmatic uses of demonstratives are particularly productive. Though affective demonstratives like (2-a) or (2-b) are well-attested in Czech and known since Mathesius (1926) (see section 4 for examples), I will concentrate on a discourse anaphoric use: a case of what one could call *pragmatic discourse anaphora*. The core data will be introduced in section 2. On the theoretical side, I will propose a new analysis of demonstratives, inspired by Elbourne (2008), Schwarz (2009), and Simonenko (2013), which, on the one hand, captures the intimate connection between demonstratives and definite articles and, on the other, offers enough flexibility to model the behavior of pragmatic demonstratives. The analysis (presented in section 3) is designed to capture the particular case of pragmatic anaphora in Czech, but section 4 will offer a speculation on how the analysis could be extended to pragmatic uses of demonstratives in general. Section 5 summarizes the paper and discusses some open issues.

2. Czech data

2.1. Background on the Czech demonstrative system

Czech has a whole variety of demonstrative expressions. The inflectional paradigm of the basic demonstrative determiner *ten* (to be glossed as DEM) is provided in Table 1.

	SG.MASC (ANIM)	SG.NEUT	SG.FEM	PL (MASC.ANIM)
NOM	ten	to	ta	ty (ti)
ACC	ten (toho)	to	tu	ty
GEN	toho	toho	té	těch
PREP	tom	tom	té	těch
DAT	tomu	tomu	té	těm
INSTR	tím	tím	tou	těmi

Table 1: The paradigm of the demonstrative determiner *ten*

Besides the determiner *ten* (which can function as a pronoun as well) there is a range of demonstratives for various ontological categories (summarized in Table 2): *tady* 'here' (locative proximal), *tam* '(to) there' (locative/directional distal), *sem* 'to here' (directional proximal), *tudy* 'via (t)here' (path), *tolik* 'so/this many/much' (amount), *teď* 'now' (temporal present), *tehdy* '(back) then' (temporal past), *tak* 'so' (manner), and *takový* 'such' (kind). Most of these demonstratives have a deictic/indexical use (the exception being *tehdy*) and many have an anaphoric use (in particular *ten, tam, tolik, tehdy, tak,* and *takový*). In addition, there are a number of morphemes that can modify these demonstratives (sometimes called "reinforcers"), with some gaps in the paradigm of

the different ontological categories: the postfixes *-hle* (deictic (proximal)) and *-to* (deictic proximal/anaphoric), and the semi-free morphemes *tady* 'here' (deictic proximal) and *tam* 'there' (deictic distal).[2] The last mentioned ones are demonstratives themselves, as can be seen by the capacity to be modified by *-hle*.[3]

	BASIC	DEIC(.PROX)	DEIC.PROX/ANAPH	DEIC.PROX	DEIC.DIST
DET/PRON	ten	ten**hle**	ten**to**	**tady**(hle) ten	**tam**(hle) ten
LOC.PROX	tady	tady**hle**	%tady**to**	*	*
LOC/DIR.DIST	tam	tam**hle**	%tam**to**	*	*
DIR.PROX	sem	sem**hle**	*	*	*
PATH	tudy	tudy**hle**	%tudy**to**	**tady**(hle) tudy	**tam**(hle) tudy
AMOUNT	tolik	%tolik**hle**	*	*	*
TEMP.PRES	teď	%teď**hle**	*	*	*
TEMP.PAST	tehdy	*	*	*	*
MANNER	tak	tak**hle**	tak**to**	%**tady** tak	*
KIND	takový	takový**hle**	takový**to**	%**tady** takový	*

Table 2: Demonstrative modifiers (reinforcers) as applied to different ontological categories

For a comprehensive discussion of the Czech demonstrative system and an extensive literature overview, I refer the reader to Berger (1993). The present paper will concentrate on the determiner *ten,* as it is the only one that allows for pragmatic uses.

2.2. Canonical vs. pragmatic anaphoric uses of *ten*

In its discourse anaphoric use, the demonstrative determiner *ten* exhibits a systematic ambiguity. Upon the canonical reading, it presupposes the existence of a unique referent in the extension of its NP complement. The uniqueness often results from the process of an "easy" accommodation, relying on the common knowledge of the interlocutors. This accommodation may give rise to the intuition that the unique referent is being selected from a non-singleton set of potential referents (the extension of the NP prior to the accommodation). Upon the pragmatic reading, there is no uniqueness presupposition. Instead, the NP complement remains semantically (type-wise) intact and the demonstrative contributes a reminder that the NP complement or even the utterance in which it occurs is part of previous *common discourse,* which I define (in allegiance to Stalnaker's 1970 concept of common ground) as the set of utterances that the interlocutors know have been made.[4]

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[2]A "postfix" is a suffix that always attaches last, even after inflectional endings. In this sense, it is a borderline case between suffixes and clitics.

[3]The demonstrative determiner *ten* can be doubled when combined with *-hle,* giving rise to expressions like *tenhleten, tohohletoho,* etc. This kind of doubling was studied for Slovenian by Marušič and Žaucer (2012).

[4]To the best of my knowledge, Adamec (1983) was the first one to discuss pragmatic anaphoric uses of demonstratives in Czech (further noting that they do not exist in Russian). Adamec recognizes the reminding function of this use of demonstratives and notices that what is being reminded is typically not just the complement NP itself but rather a

In the examples below, the (a)-readings are canonical and the (b)-readings are pragmatic. The canonical readings should be understood by readers straightforwardly, as they are (presumably) present in every language. The only example where the canonical reading is very difficult to find a context for is (4). It would be felicitous in a situation where temperature measurement is normally associated with an additional parameter that can take different values. Suppose, for instance, the counterfactual scenario in which temperatures come in different colors: 35 degrees (just as any other temperature) can be blue, red, etc. In that case, the reading (4-a) could be quite natural, saying, e.g, that it is supposed to be blue (rather than red) 35 degrees tomorrow.

But let us turn to the pragmatic readings, which I have had troubles explaining to people who do not speak Czech. For that reason, I would like to spell out a concrete context in which the pragmatic reading of each example is felicitous. For ease of presentation, suppose that the utterances are made by Ann in a conversation with Bob. Consider (3) first: Ann and Bob are discussing a serious problem they have with their landlord. Bob suggests that they could seek advise with their common friend Mirek. Ann is not convinced at first but then she realizes that they've heard that Mirek is a lawyer, uttering (3) as an expression of this realization. The speaker-oriented particle *vlastně* contributes to this "sudden realization" reading. Ad (4): Ann and Bob put together plans for tomorrow. Bob suggests that they could go play basketball. Ann counters that it might be too hot for basketball by uttering (4-a), reminding Bob of the weather forecast they heard recently. Ad (5): Ann and Bob are partners and are at a party. It is getting late and Bob suggests to go home. But Ann still had not managed to speak to their common friend Jana (who is also at the party) and utters (5), in order to remind Bob that Ann planned to speak to her. Ad (6): Suppose that Bob suggests that the linguistics department takes over some faculty-level administrative burden, after which Ann counters with (6), reminding Bob that the department still does not have a secretary (as Ann believes Bob had surely heard).[5]

(3) Mirek je vlastně **ten   právník**.   DEM + PREDICATIVE NP
     Mirek is PART   DEM lawyer
     a. 'Mirek is the lawyer [that we met at the party yesterday].'
     b. 'Mirek is a lawyer [as I've just realized we've heard].'

(4) Zítra   má být   **těch 35 stupňů**.   DEM + DEGREE-DENOTING NP
     tomorrow has be.INF DEM 35 degrees
     a. #'Tomorrow, it's supposed to be those 35 degrees [and not some other 35 degrees].'
     b. 'Tomorrow, it's supposed to be 35 degrees [remember, we spoke about it supposing to be 35 degrees tomorrow].'

whole utterance that was made about it. This brings him to the conclusion that "reminding" demonstratives are a sort of propositional modifiers, akin to discourse particles.

[5]As noticed by Amy Rose Deal, the pragmatic reading of example (6) could be analyzed as a case of modal subordination. I admit that this is the case and include the example only for the sake of completeness.

(5)   Potřebovala bych   si   promluvit s   **tou Janou**.   DEM + REFERENTIAL NP
      need   SUBJ.1SG REFL speak.INF with DEM Jana

   a.   'I need to speak with that Jana [that we met yesterday].'
   b.   'I need to speak with Jana [remember, we spoke about speaking to her].'

(6)   Katedra   lingvistiky ještě hledá **tu sekretářku**.   DEM + NON-SPECIFIC NP
      department linguistics still looks.for DEM secretary

   a.   'The linguistics department is still looking for the secretary [that disappeared yester-day].'
   b.   'The linguistics department is still looking for a secretary [remember, we spoke about them needing one].'

There is a way of distinguishing the canonical reading from the pragmatic one by adding further discourse. In particular, the two readings are each associated with a distinct reaction to a pre-supposition failure. If the uniqueness presupposition of the canonical reading is not satisfied, the hearer reacts by wondering about the identity of the individual that the speaker intended to refer to. A reaction to the pragmatic reading, on the other hand, involves expressing the inability to recollect a relevant utterance about the NP complement. Below, I provide particular examples that complement (5) – (7-a) as a possible reaction to reading (5-a) and (7-b) as a reaction to (5-b).

(7)   **Expressing presupposition failures on the two readings**

   a.   Počkej, s   kterou Janou?
        wait   with which Jana
        'Wait a minute, with which Jana?'
   b.   Počkej, nevzpomínám   si,   že bys   mi říkala, že si   potřebuješ
        wait   NEG.remember.1SG REFL that SUBJ.2SG me said   that REFL need.2SG
        promluvit s   Janou.
        speak   with Jana
        'Wait a minute, I can't remember you telling me that you wanted to speak with Jana.'

Before we move on, I should point out that the utterance that is being reminded of need not neces-sarily be (a part of) the utterance in which the demonstrative occurs. Consider example (8), which can be uttered in the same situation as (5) (described in the paragraph above (6)), contributing the same reminder. This indicates that it is inadequate to think of the pragmatic demonstrative as a propositional modifier (an idea put forth by Adamec, 1983), one that would take the whole proposition as its argument and contribute the comment that this proposition has been uttered: the utterance (8) is being made for the first time.

(8)   Tu   Janu nechám na jindy.
      DEM Jana let.1SG for other.time
      'I will postpone [speaking with] Jana for some other time. [remember, we spoke about
      speaking to her].'

To sum up: The Czech demonstrative *ten,* on top of serving the standard anaphoric function, can be
used as a reminder of an utterance in the common discourse (and by extension the semantics it con-
veys) which is somehow "about" the NP complement of the demonstrative. The NP complement
can be of any type (e.g., property-denoting, predicative, referential, non-individual-denoting) and
its type remains unaffected by the demonstrative. The utterance that is being referred back to by
help of the demonstrative must be, in one way or another, relevant to the presently made utterance.
Although it is frequently the case that the reminded-of utterance is semantically identical to the
one that is just being made, this is by no means a necessity.

3. Analysis

The analysis I propose intends to find an answer to the following questions raised by the dataset in
section 2: 1. How can it be that a single demonstrative determiner sometimes does and other times
does not have a semantic contribution? 2. How is it possible that a demonstrative refers back to a
whole utterance rather than just to the referent/denotation of the demonstrative description?[6]

In a nutshell, the proposal goes as follows: Demonstratives are lexical items that can spell-out two
semantic components (following Elbourne, 2008; Schwarz, 2009; Simonenko, 2013): the unique-
ness presupposition and a relational component – establishing a relation between the denotation
of the demonstrative description and an entity being pointed at (in a literal or metaphorical sense).
These components are in principle independent of one another, making it possible for the demon-
strative to spell-out either both at once (canonical use) or the relational component only (pragmatic
use). Finally, I will argue that the key to the understanding of the observed anaphoric reference
to utterances, despite the NP attachment, lies in the notion of a deferred ostension (Quine, 1969;
Nunberg, 1979; Elbourne, 2008).

3.1. Syntax and spell-out

My syntactic account relies on the theory of nanosyntax (Starke, 2009; Caha, 2009), which of-
fers an elegant way of dealing with lexical polysemy and morphological syncretism and hence is
suitable for the situation we face: an ambiguity of a demonstrative determiner. In nanosyntax,
the syntactic information of a lexical item is represented as a syntactic constituent or a sequence
of heads (rather than a bundle of features as, for instance, in distributed morphology). The post-

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[6]The term "demonstrative description" (built after "definite description" and adopted from Wolter 2006) refers to
an NP with a demonstrative determiner, e.g. *that man.*

syntactic lexical insertion respects the superset principle, according to which a lexical item matches a piece of syntax (and hence can be inserted) if the syntactic representation of the item is a superset of that piece of syntax. The insertion is further constrained by the so called elsewhere principle (Kiparsky, 1973), which prefers inserting the lexical item which provides the best fit (in this case: the smallest superset) of the given piece of syntax.

Let us now get back to demonstratives. I propose that the lexical entry of a demonstrative or more precisely the phonology-syntax association in that entry is as in (9): the exponent /ðæt/ corresponds (⇔) to the sequence of two heads – Dem and D.[7] For comparison, I provide the lexical entry of a definite article, whose exponent /ðə/ corresponds to D only.

(9)   **Lexical representation of *that***
       /ðæt/ ⇔
              Dem   D   . . .

(10)   **Lexical representation of *the***
       /ðə/ ⇔ D   . . .

Suppose now that the syntax can generate all the structures in Table 3. What are the possible exponents of these structures given the lexical entries above and the nanosyntactic principles? The syntactic representation of the demonstrative matches (is a superset of) all the structures and therefore the demonstrative could in principle spell out all of them. However, it can only spell out Dem+D and Dem; it cannot spell out D alone because it finds a better match in the syntactic representation of the definite article. In other words, the demonstrative is ruled out from spelling out D on the grounds of the elsewhere principle.[8] The definite article, in turn, is only a superset of D alone and cannot spell out any structure with Dem.[9]

I have demonstrated how a single lexical entry for a demonstrative can spell out two different syntactic structures, namely Dem+D and Dem alone. What is important is that there are potentially distinct lexical entries for phonological and semantic purposes: even if a single exponent spells out a complex structure, such as Dem+D, it can hold that each individual component of that structure gets interpreted individually, i.e., Dem and D each receives its own interpretation. Thus, spelling out two different syntactic structures – Dem+D or Dem – results in two different, albeit related meanings – the canonical one and the pragmatic one, respectively (as indicated by the last column of Table 3). We now have the first part of an answer to our first question: How can it be that a

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[7]Much of the syntactic literature assumes the opposite order/hierarchy, namely one where D scopes over Dem. See footnote 14 and the associated main-text discussion for a semantic reason why the Dem over D order is preferred in the present approach.

[8]There is a prediction for articleless languages, which should be able spell out D by a demonstrative because there is no article to block it. This prediction is relativized, however, by one's assumption about the syntax of articleless languages: it holds only if articleless languages possess/project the category D in the first place (cf. Bošković, 2009).

[9]Some readers may wonder what blocks spelling out D by *the* and subsequently spelling out Dem by *that,* giving something like *that the NP* as a result. There are at least two ways to rule this out: by the minimize exponence principle (Siddiqi, 2006), which forces fewer spellouts whenever possible (*that the* is thus blocked because *that* achieves the same in a single step), or by the assumption that spellout is cyclic, bottom-up, and that subsequent spellout steps "override" previous ones (under structure preservation); see Starke's (2009) "biggest wins" theorem.
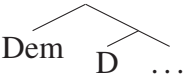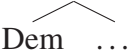
LABEL	STRUCTURE	EXPONENT		TYPE OF DEM
Dem+D	Dem D …	*that*	(*the* ruled out by superset)	canonical
Dem	Dem …	*that*	(*the* ruled out by superset)	pragmatic
D	D …	*the*	(*that* ruled out by elsewhere)	

Table 3: Structures and their exponents

single demonstrative sometimes does and other times does not have a semantic contribution? The (part of the) answer is that not all demonstratives spell out the D component.

3.2. Semantics

On the present approach, asking what the denotation of a demonstrative is amounts to asking what the denotation of its possible components is, i.e., D and Dem. But before we turn to discussing the interpretation of these individual heads, I will provide a background on Schwarz's (2009) analysis of strong definite articles and Elbourne's (2008) analysis of demonstratives, on which the present approach builds.

3.2.1. Background: Schwarz (2009) and Elbourne (2008)

Schwarz and Elbourne both have the idea that demonstratives (or strong definite articles) are semantically more specified versions of (weak) definite articles: they contribute what articles do, but they do more than that.[10] The definite-article contribution is essentially the iota type-shift (property → entity; Partee 1987) and the uniqueness/maximality presupposition it comes with. A particular situation-semantic implementation of this is in (11) (relying on Schwarz's assumptions).

(11) $[\![\text{D/the}]\!]^g = \lambda s_s.\lambda P_{\langle s,et \rangle} : |P(s)| = 1.\iota x[P(s)(x)]$

The additional contribution, specific to demonstratives, is the relational component. This is a requirement that the denotation of a demonstrative description be related (by a two-place relation R) to something in extra-linguistic reality or in previous discourse. According to Schwarz, R is

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[10]Schwarz (2013) hypothesizes that his 2009-analysis of strong definite articles could be applied to demonstratives in articleless languages.

always the identity relation ($=$) and the relevant entity (y) is a referent introduced in previous discourse. The resulting semantics is in (12).

(12) $[[\text{the}_{\text{strong}}/\text{that}]]^g = \lambda s_s.\lambda P_{\langle s,et \rangle}.\lambda y_e : |P(s)| = 1.\iota x[P(s)(x) \wedge x = y]$

It provides the basis for an adequate account of canonical anaphoric uses of definite or demonstrative descriptions: on the one hand, they are run-of-the-mill descriptions, on the other, they establish an identity relation to a previously mentioned referent. Consider example (1-b), repeated in (13-a). The meaning of the anaphoric demonstrative/definite description is in (13-b).

(13)   a.   We met Senator Johnson. This/The politician has been in office since 2011.
         b. $[[[[[\text{this/the } s_2] \text{ politician}] y_1]]]^g = \iota x[\text{politician}'(g(2))(x) \wedge x = g(1) = \text{Johnson}']$

Elbourne's proposal, which conceptually builds on Nunberg (1993), is more complex but also more general, as it does not specify the value of the relation R. The lexical entry of a demonstrative in this system (abstracting away from the proximity/distality parameter) is provided in (14). Apart from a number of technical details, the entry differs from Schwarz's in that it involves an additional argument – the relation R between an entity (x) and an individual concept ($\lambda s'.z$). This relation corresponds to the identity relation in Schwarz's system (and indeed, the identity relation is the default value of the relational argument). The entity is the deictic component of the demonstrative (what is being pointed at) and corresponds to Schwarz's discourse referent (y). The individual concept corresponds to the denotation of the whole demonstrative description.

(14) $[[\text{DEM}]] = \lambda x_e.\lambda R_{\langle e, \langle se,st \rangle \rangle}.\lambda P_{\langle se,st \rangle}.\lambda s_s.\iota z[R(x)(\lambda s'.z)(s) \wedge P(\lambda s'.z)(s)]$

Consider example (15-a), a standard case of deictic use of demonstratives. The interpretation of *that man* is given in (15-b). In this case, the value of the entity argument (i_1) provided by the assignment function g is the individual pointed at, i.e. John. The value of the relational argument (R_2) is the identity relation. This means that the individual denoted by the demonstrative description *that man* is identical to John.

(15)   a.   Look at that man [GESTURE AT JOHN].
         b. $[[[[[\text{that } i_1] R_2] \text{ man}]]]^g = \lambda s.\iota x[\text{John}' = x \wedge \text{man}'(x)(s)]$

Let us now look at a case that substantiates the variable nature of the relational component, i.e., a case where the relation has a different value than identity. One of the core arguments comes from a phenomenon called *deferred ostension* (early observations date back to Quine 1969 and Nunberg

1979), which is characterized by a situation "in which the speaker demonstrates one thing in order to refer to another." (Elbourne, 2008: 439) An example is given in (16-a), where the speaker intends to refer to donkeys by pointing at empty fields. Obviously, the relation between what is being referred to and what is being pointed at is not the identity relation. Rather, it is one that corresponds to the predicate *is kept in*. The denotation of *this/that donkey* (again, ignoring the proximity/distality parameter) is provided in (16-b).

(16)   a.   This donkey [GESTURE AT FIELD A] is healthier than that donkey [GESTURE AT FIELD B].   (Elbourne, 2008: 439)
       b. $[\![\,[[[\text{this/that } i_1]\ R_2]\ \text{donkey}]\,]\!]^g = \lambda s.\iota x[\text{is.kept.in}'(\text{field.A}')(x)(s) \wedge \text{donkey}'(x)(s)]$

I will show how the concept and mechanism of deferred ostension can be utilized in answering our second question concerning pragmatic demonstratives: How can it be that a demonstrative description anaphorically points to something else (an utterance) than what it denotes (an NP denotation)?

Finally, I would like to sketch how Elbourne proposes to account for anaphoric uses of demonstrative descriptions, as it will be relevant for my own proposal.[11] Unlike Schwarz, who assumes that the element that enters the (identity) relation with the denotation of the demonstrative description is a *discourse referent* (a metalinguistic entity), Elbourne proposes that it is a word/phrase *occurrence* (an object language entity). For reasons of terminological consistency, I replace the term occurrence with the term utterance. An utterance is, according to Elbourne, always of type e. For this reason, it can act as the first argument of the relevant relation. And what is the value of this relation in demonstrative anaphora? It is a more specific version of the classical interpretation function $[\![.]\!]$, namely a function that interprets nouns and NPs: $[\![.]\!]_{\text{NP}}$. This function is of type $\langle e, \langle se, st \rangle \rangle$: it takes an object-language NP (type e) and returns a property (a function from individual concepts $\langle s, e \rangle$ to propositions $\langle s, t \rangle$). In more accessible terms, the relation is *has the property denoted by*. Technically, anaphora in Elbourne's account is a case of deferred ostension, simply because the relation involved is not identity. Consider, once again, our example with an anaphoric demonstrative description – *this politician*. If the assignment function assigns the utterance *Senator Johnson* to i_1 and $[\![.]\!]_{\text{NP}}$ to R_2, we arrive at the interpretation in (17-b).

(17)   a.   We met Senator Johnson. This politician has been in office since 2011.
       b. $[\![\text{this } i_1\ R_2\ \text{politician}]\!]^g$
            $= \lambda s.\iota x[\text{has.the.property.denoted.by}'(\textit{Senator Johnson})(x)(s) \wedge \text{politician}'(x)(s)]$

In sum, just as deictic demonstratives establish a relation between something in the extra-linguistic reality and the denotation of the demonstrative description (typically but not always identity),

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[11]Elbourne only explicitly treats donkey anaphora (section 3.8 of his paper), but as far as I can tell, the proposal carries over to run-of-the-mill discourse anaphoric uses.

anaphoric demonstratives establish a relation between something in previous discourse and the denotation of the demonstrative description.

3.2.2. Proposal: Semantics of D and Dem

In section 3.1, I proposed that demonstratives are lexically composed of two heads – Dem and D – and that, due to nanosyntactic principles, they can stand either for Dem+D or for Dem alone. Understanding the semantics of demonstratives in this system therefore amounts to understanding what the individual semantic contributions of Dem and D are and how they interact. The core idea is that the two components of demonstratives (or of strong definite articles) postulated by Elbourne (2008) (and Schwarz 2009), namely uniqueness and relationality, are distributed over the two heads that the demonstrative can spell-out: D and Dem, respectively.[12] It follows that if a demonstrative spells out Dem alone, the uniqueness component will be missing. This is the basic (and general) tool that the present analysis offers for the understanding of pragmatic readings of demonstratives. Let us now move on to the particular semantic proposal.

Concerning D, I have nothing new to contribute. I simply assume that D has the semantics of a Fregean definite article: it contributes the uniqueness presupposition and shifts properties to individuals. The semantic lexical entry is repeated below.

(18) $[\![\text{D}]\!] = \lambda s_s.\lambda P_{\langle s,et\rangle} : |P(s)| = 1.\iota x[P(s)(x)]$

The crucial contribution of Dem is the relational component, establishing a relation of the kind described above. What Dem must lack, on the other hand, is the uniqueness presupposition and the type-shifting capacity. One reason for this is theory-internal: uniqueness plus type-shifting is a function attributed to D and it would make little sense to reiterate it in Dem. Another reason is empirical: pragmatic uses of demonstratives need not impose any uniqueness requirement (as established in section 2) and appear to leave the type of their NP complement intact (sections 1 and 2). Moreover, various kinds of NPs can be complements to pragmatic demonstratives. All these considerations necessitate type-flexibility upon Dem's NP-argument and consequently upon the second argument of the relational variable. We arrive at the picture in (19): Dem is a three-place function, taking an index i_1 (type e), a relation R_2 (type $\langle e, \langle \alpha, st\rangle\rangle$, for any type α), and an NP (type α) as its arguments, and returns the meaning of its NP argument (type α) as its value. Assuming that the relational contribution is presuppositional in nature, we can say that Dem functions as a partial identity function (type $\langle \alpha, \alpha\rangle$) upon its NP argument.

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[12]See Simonenko (2013) for a similar, albeit differently motivated proposal.

(19)
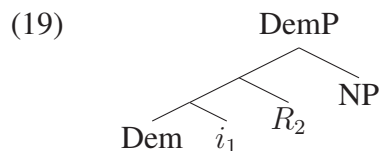
The corresponding lexical entry of Dem is in (20). It presupposes that the value of i_1 is related by the value of R_2 to the denotation of the NP argument (in the utterance situation s_u) and returns the denotation of the NP argument as its final value.[13]

(20) $[\![\mathrm{Dem}]\!]^{g,s_u} = \lambda x_e.\lambda R_{\langle e,\langle\alpha,st\rangle\rangle}.\lambda X_\alpha : R(x)(X)(s_u).X$

Before we turn to an application of this proposal to the Czech data from section 2, let us make explicit how the system works in the two core cases: Dem+D and Dem only. In the former case, Dem selects a definite description (type e) and returns its denotation if it is related by the contextually determined relation to the contextually determined entity.[14] In the latter case, Dem selects an NP (whatever its denotation is) and returns its denotation if it is related by the contextually determined relation to the contextually determined entity. There are no restrictions on the denotation of this "bare" NP or, more precisely, the restrictions are independent of the present proposal. The NP could be property-denoting (type $\langle s, et\rangle$), individual- or kind-denoting (type e or $\langle s, e\rangle$), and in principle also quantificational (type $\langle\langle s, et\rangle, t\rangle$), a case I leave aside in this paper.

3.2.3. Application to anaphoric demonstrative descriptions in Czech

Let me start with a brief reminder of the empirical situation described in section 2. We saw that DEM+NP combinations in Czech yield a systematic ambiguity between canonical demonstrative description readings and what I called pragmatic readings. On the pragmatic reading, the demonstrative (i) leaves the semantics of the NP complement intact and (ii) contributes a reminder that there is a relevant utterance in previous common discourse that was about the denotation of the NP. This is schematically summarized in (21) for two of the cases discussed in section 2.

(21)   a. $[\![\mathrm{DEM_{prag}\ NP_{\langle s,et\rangle}}]\!] = [\![\mathrm{NP_{\langle s,et\rangle}}]\!]$ + reminder of a relevant utterance about $[\![\mathrm{NP_{\langle s,et\rangle}}]\!]$
         b. $[\![\mathrm{DEM_{prag}\ NP_e}]\!]$ $= [\![\mathrm{NP_e}]\!]$ + reminder of a relevant utterance about $[\![\mathrm{NP_e}]\!]$

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[13]I take the relational component to be presuppositional essentially for the purpose of exposition. As far as I am concerned, its exact semantic status is an open issue.

[14]This makes clear why Dem has to scope over D rather than the other way around. If Dem is to establish a relation between the DP (or the whole demonstrative description in previous approaches) and some entity, then D has to apply before Dem. Alternatively, if syntax necessitated a D over Dem hierarchy, then D would have to be a semantic argument of Dem, which would require a serious reformulation of D's contribution to the compositional semantics.

Consider now, first in informal terms, how the two observations are accounted for in the present analysis. The first observation is accounted for by the assumption that pragmatic demonstratives correspond to (spell out) Dem alone (the following correspondences hold: $\text{DEM}_{prag} \Leftrightarrow$ Dem and $\text{DEM}_{can} \Leftrightarrow$ Dem+D). Since Dem acts as a (partial) identity function, the semantics of the NP complement remains unaffected by Dem. The second observation is accounted for by the relational presupposition introduced by Dem, incorporating Elbourne's (2008) insight about deferred ostension. I assume that the case at hand is indeed an instance of deferred ostension: the denotation of the demonstrative description equals the denotation of the NP, but what is being pointed at (metaphorically) is some relevant utterance in previous common discourse.[15] The relation implicated is an aboutness relation of sorts: the utterance is about the NP denotation.[16] One comment is in order before we move on to the formalization. Standard deferred ostension represents a demonstrative/indexical strategy of the speaker to help the hearer figure out the referent even in its absence in the utterance situation. The present application of deferred ostension is somewhat different because it does not serve the purpose of determining a referent or, more generally, denotation of a demonstrative description: the referent/denotation is clear enough to the hearer even without the demonstrative. What *does* it do then? By establishing a relation to previous common discourse, the speaker helps the hearer find a particular context in which the presently made utterance is relevant.

I will now present an application of the formal analysis to two particular examples (of the kind in (21)). Let us start with a case of DEM + proper name, representing the application of a demonstrative to a referential expression (type e). As an example, take the demonstrative description *tou Janou* 'that Jana' in (22), repeated from (5).

(22)   Potřeboval bych   si   promluvit s   **tou Janou**.   DEM + REFERENTIAL NP
               need   subj.1sg refl speak.inf with DEM Jana

      a.   'I need to speak with that Jana [that we met yesterday].'
      b.   'I need to speak with Jana [remember, we spoke about speaking to her].'

Under its pragmatic reading (22-b), the meaning of the demonstrative *tou* equals the meaning of Dem alone. The meaning of *Janou* is simply the individual Jana. The relational presupposition contributed by Dem/*tou* is in (23-a); if it is satisfied, the denotation of the whole demonstrative description is equal to Jana, as captured in (23-b).

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[15]This might in fact be too restrictive: It is possible to find scenarios where the interlocutors do not have the same utterance in mind. It seems enough if they know that there was a relevant utterance (possibly different for each interlocutor). This would call for a modification under which the deictic component (what is being pointed at) is modeled not as a variable that is free but that is existentially bound in a presupposition; see the modified entry in (i).

(i) $[\![\text{Dem}]\!]^{g,s_u} = \lambda R_{\langle e,\langle \alpha,st \rangle\rangle}.\lambda X_\alpha : \exists x_e[R(x)(X)(s_u)].X$

[16]In Reinhart's (1981) seminal work, 'being about something' is a property of propositions. Yet, what a proposition is about is often only determined in a particular discourse, making utterances better candidates for the domain of 'being about something'.

(23)   a. $[\![\ [_{\text{DemP}} \text{ Dem } i_1 \ R_2 \ [_{\text{NP}} \text{ Janou}_e]] \ ]\!]^{g,s_u}$ *is defined if*
              in the utterance situation s_u, some relevant utterance in previous common discourse
              $[= g(1)]$ is about $[= g(2)]$ Jana. *If defined, then*
        b. $[\![\ [_{\text{DemP}} \text{ Dem } i_1 \ R_2 \ [_{\text{NP}} \text{ Janou}_e]] \ ]\!]^{g,s_u} = \text{Jana}$

For comparison, consider the canonical reading (22-a). In this case, the demonstrative *tou* stands
for (spells out) two heads: Dem and D. The structure to be interpreted is therefore the one in (24).
The application of D to *Janou* results in a type clash: *Janou* is of type e, but D requires type $\langle s, et \rangle$
from its NP argument. This coerces a type shift of *Janou* to the property $\lambda s.\lambda x.x$ is Jana in s –
a set of situation-individual pairs such that the individual(s) is/are Jana(s) in that situation. The
uniqueness requirement introduced by D restricts the possible values for the resource situation (s_3)
to those in which there is a single Jana. As indicated in (22-a), the relevant situation can be one
in which we spoke to Jana yesterday. This is the mechanism of domain restriction (down to a
singleton) and it corresponds to the implicit choice of the right Jana (out of a potentially larger set
of Janas).

(24) $[_{\text{DemP}} \text{ Dem } i_1 \ R_2 \ [_{\text{DP}} \text{ D } s_3 \ [_{\text{NP}} \text{ Janou}_e]]]$

Taking the coercion into account, the meaning of the DP is in (25) and the meaning of the whole
DemP, i.e., the expression *tou Janou*, on its canonical reading, is in (26). I leave aside what the
particular value of the demonstrated entity and the corresponding relation could be.

(25)   a. $[\![\ [_{\text{DP}} \text{ D } s_3 \ [_{\text{NP}} \text{ Janou}_{\langle s,et \rangle}]] \ ]\!]^{g,s_u}$ *is defined if*
              there is a single Jana in the resource situation $[= g(3)]$. *If defined, then*
        b. $[\![\ [_{\text{DP}} \text{ D } s_3 \ [_{\text{NP}} \text{ Janou}_{\langle s,et \rangle}]] \ ]\!]^{g,s_u} = \iota x[\text{Jana}(g(3))(x)]$

(26)   a. $[\![\text{Dem } i_1 \ R_2]\!]^{g,s_u}(\iota x[\text{Jana}(g(3))(x)])$ *is defined if*
              the single Jana in $g(3)$ is related by a contextually determined relation $[= g(2)]$ to
              some contextually determined entity $[= g(1)]$. *If defined, then*
        b. $[\![\text{Dem } i_1 \ R_2]\!]^{g,s_u}(\iota x[\text{Jana}(g(3))(x)]) = \iota x[\text{Jana}(g(3))(x)]$

Let us now turn to the case DEM + predicative NP, representing the application of a demonstrative
to a property-denoting expression (type $\langle s, et \rangle$). Take example (27), repeated from (3).

(27)   Mirek je vlastně **ten   právník**.   DEM + PREDICATIVE NP
        Mirek is PART   DEM lawyer
        a.   'Mirek is the lawyer [that we met at the party yesterday].'
        b.   'Mirek is a lawyer [as I've just realized we've heard].'

The meaning of the pragmatic use of the demonstrative description *ten právník* is provided in (28). Notice that the system correctly derives the non-referential nature of the demonstrative description, which in turn affords a standard predicative interpretation of (27).

(28)　　a.　　$[\![\, [_{\text{DemP}} \text{ Dem } i_1 \, R_2 \, [_{\text{NP}} \text{ právník}_{\langle s,et \rangle}]] \,]\!]^{g,s_u}$ *is defined if*
　　　　　　in the utterance situation s_u, some relevant utterance in previous common discourse
　　　　　　$[\, = g(1)]$ is about $[\, = g(2)]$ the property of being a lawyer. *If defined, then*
　　　　b.　　$[\![\, [_{\text{DemP}} \text{ Dem } i_1 \, R_2 \, [_{\text{NP}} \text{ právník}_{\langle s,et \rangle}]] \,]\!]^{g,s_u} = \lambda s.\lambda x[\text{lawyer}'(s)(x)]$

Compare this to the canonical reading of the given demonstrative description. In this case, the demonstrative spells out both Dem and D and therefore conveys uniqueness, as indicated in (29). The meaning of the whole demonstrative description is in (30). It is a referential expression and the resulting interpretation of (27) corresponds to equation rather than true predication.

(29)　　a.　　$[\![\, [_{\text{DP}} \text{ D } s_3 \, [\text{NP právník}_{\langle s,et \rangle}]] \,]\!]^{g,s_u}$ *is defined if*
　　　　　　there is a single lawyer in the resource situation $[\, = g(3)]$. *If defined, then*
　　　　b.　　$[\![\, [_{\text{DP}} \text{ D } s_3 \, [\text{NP právník}_{\langle s,et \rangle}]] \,]\!]^{g,s_u} = \iota x[\text{lawyer}'(g(3))(x)]$

(30)　　a.　　$[\![\text{Dem } i_1 \, R_2]\!]^{g,s_u}(\iota x[\text{lawyer}'(g(3))(x)])$ *is defined if*
　　　　　　the single lawyer in $g(3)$ is related by a contextually determined relation $[\, = g(2)]$ to
　　　　　　some contextually determined entity $[\, = g(1)]$. *If defined, then*
　　　　b.　　$[\![\text{Dem } i_1 \, R_2]\!]^{g,s_u}(\iota x[\text{lawyer}'(g(3))(x)]) = \iota x[\text{lawyer}'(g(3))(x)]$

In sum, I demonstrated how the two different readings of demonstrative descriptions in Czech can be modeled using the syntactic and semantic decomposition proposed in sections 3.1 and 3.2.2, combined with the assumption that deferred ostension is a concept that can be applied to discourse anaphora and with a different purpose.

4. Extension: Affective demonstratives

The phenomenon of affective (also emotive) demonstratives seems relatively widespread; so far, it has been documented at least for Czech (Mathesius, 1926), English (Lakoff, 1974), German (Potts and Schwarz, 2010), and Japanese (Davis and Potts, 2010). Since the Czech data have never been exposed to the field of formal linguistics, let me include a number of examples, complementing the English ones provided in the introduction. Some prototypical examples are provided in (31). Concerning (31-a), Mathesius (1926) notices that the affective character of demonstratives is intensified by the first-person possessive pronouns.

(31) a. Ten náš tatínek nějak   stárne.   (Mathesius, 1926: 40)
          DEM our dad   somehow gets.old
          'Our dad is getting old [and we feel affectionate about him].'
      b. To   sluníčko dnes hřeje.   (Mathesius, 1926: 41)
          DEM sun.DIM today heats
          'It's hot in the sun today [and we find it pleasant].'

Mathesius further observes that the demonstrative and possessive determiners sometimes alternate with zero, giving rise to a scale of affectiveness – from the least affective (32-a) to the most affective (32-c).

(32) a. Jen kdyby mne hlava nebolela.   (Mathesius, 1926: 41)
          only if   me head NEG.hurt
      b. Jen kdyby mne **ta**   hlava nebolela.
          only if   me DEM head NEG.hurt
      c. Jen kdyby mne **ta**   **má** hlava nebolela.
          only if   me DEM my head NEG.hurt
          'Only if I didn't have a headache!'

I leave a precise semantic analysis of affective demonstratives for another occasion. Nevertheless, I would like to point out that the present proposal might offer a useful syntactico-semantic substrate for analyzing affective demonstratives. If we assume that they spell out Dem alone (rather than Dem+D), we derive the generalization that they do not shift the type of their NP complement. Consider the Czech examples above. All of them involve situationally unique definite NPs ('dad', 'sun', 'head'), which are normally expressed by bare NPs in Czech. The demonstrative therefore does not play the role of D. The Dem-based analysis also offers a new perspective of Lakoff's (1974) conjecture that affective demonstratives are used in order to evoke hearer's solidarity with the speaker's own views. It does not seem entirely unlikely that the solidarity could be modeled using the relational component contributed by Dem. It is possible, for instance, that the demonstrative establishes a relation between the NP denotation (referent) and some relevant common ground attitudes, i.e., attitudes held by all the interlocutors.

5. Summary and open issues

I proposed a new syntax-semantics for pragmatic demonstratives. These are demonstratives which lack the properties of definite articles, particularly the uniqueness presupposition and the type-shifting capacity. On the syntactic side, the proposal builds on nanosyntactic principles (Starke, 2009), which provide an elegant way of dealing with the apparent ambiguity of demonstratives. In particular, demonstratives either spell out two heads – Dem and D, a structure underlying canonical demonstratives, or only one head – Dem, underlying pragmatic demonstratives. On the semantic

side, I argued that the contribution of demonstratives as viewed by Elbourne (2008) (and similarly so by Schwarz 2009 for the case of strong definite articles) should be distributed over the two heads: D hosts the definite-article semantics (uniqueness, type-shifting) and Dem hosts a relational component, establishing a relation between the denotation of the demonstrative description and some contextual entity. With these instruments at hand, I provided a detailed analysis of Czech anaphoric pragmatic demonstratives (novel to the formal literature). I argued that they establish a relation between the NP denotation and an utterance in previous common discourse such that the utterance was about that NP denotation – a relation that relies on the concept of deferred ostension (Elbourne, 2008). The proposal introduces a new method for analyzing pragmatic demonstratives in general. In section 4, I suggested how it could be extended to affective (emotive) demonstratives, a kind of pragmatic demonstratives attested cross-linguistically.

Many issues remain open, of course. One that particularly stands out is the issue of the relational component. Elbourne's (2008) (or in fact Nunberg's 1993) idea that demonstratives establish a relation between the denotation of the demonstrative description and something else is powerful and attractive in its flexibility. The present analysis might be taken as evidence that such flexibility is in fact exactly what is needed. On the other hand, by modeling the relation as an unrestricted free variable, the approach clearly allows for many more kinds of relations than the ones attested so far (a relation of the DemP denotation to pretty much anything is a viable option). Further cross-linguistic investigations might reveal that languages do indeed make use of these various options. On the other hand, some quite severe restrictions are certainly needed to constrain the use of demonstratives within a single language. Take some examples: English does not seem to have anaphorically used pragmatic demonstratives. Affective demonstratives cannot be mechanically translated from one language to another. Where do these restrictions come from? Can they be derived from independent facts of individual languages or are we dealing with lexical idiosyncrasy? As far as I can tell, answers to these questions are not even at our research horizon.

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The universal measurer[1]

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Abstract. It is well-known that numerically modified container phrases such as *four glasses of water* are ambiguous between individuating and measure interpretations. We show that this ambiguity arises for numerically modified atomic predicates generally, including e.g. *four oranges* and *four grains of rice*, but not for measure phrases like *four ounces of water*. We develop an analysis that accounts for this generalization in terms of a type-shifting principle, the Universal Measurer.

Keywords: quantizing nouns, counting, measuring, individuation, type-shifting

1. Individuating and Measuring

Many have observed that utterances with numerically modified CONTAINER PHRASES such as *four glasses of water* are ambiguous (Selkirk 1977, Chierchia 1998, Landman 2004, Rothstein 2009, 2010, Scontras 2014). (1a), for example, has an INDIVIDUATING INTERPRETATION (II), which is paraphrased in (1b), and a MEASURE INTERPRETATION (MI), paraphrased in (1c).

(1)   a. Mary put four glasses of water in the soup.

        b. There's a group of four glasses x such that each of x is filled with water and Mary put x in the soup.   (II)

        c. There's an amount of water x such that x measures four glasses worth and Mary put x in the soup.   (MI)

For the II, suppose that Mary heats water for coffee in an odd way: she places glasses full of water in boiling soup. In this situation, (1a) is true even though no water touches the soup. For the MI, suppose instead that Mary is making soup, and that the recipe calls for four glassfuls of water. Mary takes a certain glass, fills it with water, empties the water into the soup, and then repeats the process three more times. In this situation, (1a) is true even though no glass touches the soup.

The literature on individuating/measure (I/M) ambiguities has tended to focus exclusively on container phrases, perhaps suggesting that I/M ambiguities arise due to the meanings of container nouns. This paper's primary empirical contribution is to show that I/M ambiguities are not limited to container phrases. Rather, other countable predicates such as *grain of rice* and *orange* also give rise to I/M ambiguities. For example, (2a) is ambiguous between the II in (2b) and the MI in (2c).

(2) a. Mary put four oranges in the punch.

  b. There's a group of four oranges x such that Mary put each of x in the punch.   (II)

  c. There's an amount of orange x such that x measures four oranges worth and Mary put x in the punch.   (MI)

For the II, suppose that Mary wants to decorate already made punch. She thinks that floating fruit would look nice, so she places a few apples, some pears, and four oranges in the punch. For the MI, suppose instead that Mary's punch recipe calls for four oranges worth of pulverized orange. Mary has no oranges handy, but she does have some prepackaged orange pulp. She pours a certain amount into the punch, estimating it to be approximately four oranges worth. (2a) is an acceptable, true answer to the question *How many oranges did Mary put in the punch?* in both scenarios.

Container nouns like *glass* belong to a larger category of nouns Scontras (2014) calls QUANTIZING NOUNS, or nouns which help facilitate counting and other forms of measurement. These also include MEASURE NOUNS like *ounce* and ATOMIZER NOUNS like *grain*. All three combine with an *of*-phrase to form what Rothstein (2009) calls a "classifier phrase", e.g. *glass of wine*, *ounce of water*, or *grain of rice*. However, we will argue here that there is an important asymmetry between these different sorts of nouns: while container nouns and atomizer nouns give rise to I/M ambiguities, measure nouns do not. Rather, measure phrases like *four ounces of water* only have MIs.[2] As evidence, consider the difference in acceptability between the quantizing nouns in (3).

(3) [Context: There are four glasses filled with wine, four grains of rice, and a bowl containing four ounces of water on a table. Pointing at them, Mary says:]

  Each of those four {glasses of wine / grains of rice / ??ounces of water} is for John.

According to Rothstein (2010), distributive expressions such as *each* presuppose a domain of individuated, and thus countable, objects, or "atoms" in the sense of e.g. Krifka (1989). (3) shows that atomizer phrases and container phrases on the II are ATOMIC PREDICATES: when singular, they denote sets of atomic individuals. Measure phrases, on the other hand, do not.

The theoretical contribution of this paper is to account for the generalization that atomic predicates of various sorts, including *orange*, give rise to I/M ambiguities, but measure phrases do not. We begin with the observation that both quantizing nouns and ordinary count nouns are QUANTIZED PREDICATES in Krifka's sense: they are predicates such that if an individual satisfies the predicate, no proper part of the individual does. For example, an arbitrary part of an ounce of water is not itself an ounce of water, and an arbitrary part of an orange is not itself an orange. For atomic predicates, this is expected because atomicity entails quantization. Since atoms do not have proper parts, they trivially do not have proper parts having certain properties. In contrast, quantization

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[2]cf. Champollion 2010. Apparent exceptions to this generalization include measure nouns used as container nouns, e.g. *liter of water* or *ounce of cocaine*. See Scontras 2014 for discussion.

needn't imply atomicity. For instance, suppose x and y are both quantities of water measuring an ounce. Then both satisfy *ounce of water*, yet they needn't be atoms on account of that. After all, they may have overlapping parts; it could be e.g. that y is the result of replacing half of x with a different half ounce of water. Rather, measure phrases are more plausibly what Krifka calls STRICTLY QUANTIZED PREDICATES: they are quantized but not atomic.

Our view is that I/M ambiguities arise for atomic predicates in general because it is always possible to shift an atomic predicate to a strictly quantized predicate. On this view, IIs arise due to the atomicity of the predicates in question. For example, *glass of water* denotes a set of atomic glasses by default, and the II of *four glasses of water* results from *four* functioning as a cardinality modifier, i.e. it counts the number of atomic glasses constituting a certain plurality. In contrast, MIs arise thanks to a type-shifting principle we dub THE UNIVERSAL MEASURER (UM), in homage to Pelletier's (1975) Universal Grinder and Universal Packager. UM applies "universally" to atomic predicates, effectively transforming them into measure expressions. For example, it shifts the meaning of *glass* from a predicate true of atomic glasses to a non-standard measure, or what Partee and Borschev (2012) call an AD HOC MEASURE. As a result, *four glasses of water* comes to denote quantities of water measuring four glasses worth, thus resulting in an MI. Like *ounce of water*, *glass of water* on the MI is strictly quantized since quantities of water satisfying the predicate may share overlapping parts. MIs of e.g. *four oranges* arise thanks to a "reflexivized" version of UM. Applying it to *orange* returns quantities of orange measuring so many oranges worth, again rendering *orange* strictly quantized. As a result, UM accounts for the fact that atomic predicates of various sorts are I/M ambiguous. Because UM does not have an inverse, the analysis predicts that it is not possible to shift from MIs to IIs. And since measure phrases denote (standardized) measures by default, this also correctly predicts that they do not generally have IIs.

The rest of the paper is organized as follows. In §2 we argue that I/M ambiguities arise for various sorts of atomic predicates, not just container phrases. To do so, we generalize Rothstein (2010)'s diagnostics for I/M-ambiguous container phrases and also develop novel diagnostics. Applying the diagnostics reveals that I/M ambiguities are more prevalent than has been previously recognized. §3 presents our analysis of I/M-ambiguities. We show that supplementing Scontras (2014)'s semantics for quantizing nouns with UM makes it possible to account for the pervasiveness of I/M ambiguities. Consequently, the resulting analysis both builds on and improves previous analyses.

2. Diagnosing I/M-Ambiguities

The purpose of this section is to show that I/M ambiguities are not limited to just container phrases. We present diagnostics for IIs and MIs, beginning with three diagnostics from Rothstein (2010). Though all three are applicable to container phrases, not all are applicable to atomic predicates more generally. Therefore, we develop some additional heuristics to supplement Rothstein's. Taken together, these reveal that I/M ambiguities are more prevalent than previously recognized.

2.1. Rothstein's Diagnostics

Rothstein (2010)'s first diagnostic for disambiguating container phrases involves distributive expressions such as *each*. On the II, *four glasses of water* denotes groups of four atomic glasses, each of which is filled with water. On the MI, it instead denotes quantities of water measuring four glassfuls. Because *each* presupposes a domain of atoms, it is thus compatible only with IIs:

(4)   [Context: Mary has a strange way of heating up water for coffee. She fills individual glasses with water and then places those glasses in boiling soup.]

(5)   [Context: Mary is making soup. Following the recipe, she fills a certain glass four times with water, pouring the contents each time into the soup.]

(6)   Mary put each of the four glasses of water in the soup.

The fact that (6) is acceptable in (4) but odd in (5) shows that the former induces an II of *four glasses of water*, the latter an MI. Accordingly, we call contexts like (4) INDIVIDUATING CONTEXTS and those like (5) MEASURE CONTEXTS.

Rothstein's second diagnostic involves the possibility of *-ful* suffixation. According to it, *-ful* can be acceptably suffixed to a container noun in measure contexts but not individuating contexts. And, indeed, an utterance of (7) is acceptable in (5) but not (4).

(7)   Mary put four glassfuls of water in the soup.

According to Rothstein, that's because the function of *-ful* is to transform a container noun such as *glass* into a measure noun. It denotes quantities of a substance (e.g. water) measured in terms of an ad hoc glass-unit. Consequently, *-ful* suffixation effectively forces an MI.

Rothstein's third diagnostic involves DEGREE RELATIVES. The diagnostic relies on Carlson's (1977) observation that relative clauses denoting sets of individuals can be headed by either *which* or *that*, unlike relative clauses denoting measured quantities, which are necessarily headed by *that* or a null complementizer. This diagnostic is applied to measure nouns and container nouns in (8).

(8)   a. I wanted to inspect the four ounces of water {∅/ ??which / that} Mary put in the soup.
       b. I wanted to inspect the four glassfuls of water {∅/ ??which / that} Mary put in the soup.
       c. I wanted to inspect the four glasses of water {∅/ which / that} Mary put in the soup.

(8a) shows that the measure phrase *four ounces of water* denotes only measured quantities of water. Similarly, (8b) demonstrates that *four glassfuls of water* denotes only measured quantities of water,

as expected given the meaning Rothstein attributes to *-ful*. In contrast, (8c) shows that *four glasses of water* does have an II, since it is acceptable with both kinds of relative clauses. However, because *four glasses of water* has an MI paraphrased as *four glassfuls of water*, we should expect relative clauses like the one in (8c) to be acceptably headed by *which* only in individuating contexts such as (4). This prediction is also correct.

Two of Rothstein's diagnostics can be used to support our claim that I/M ambiguities extend beyond just container phrases. Note first that *each* is acceptable with the atomizer phrase *four drops of blood* when uttered in (9) – an individuating context – but not (10) – a measure context.

(9) [Context: John and Mary are detectives at a crime scene, where rain has recently washed away four drops of blood that were on the sidewalk. Mary says:]
I saw each of the four drops of blood before the rain started.

(10) [Context: Mary is making soup. The recipe calls for four drops of pig blood. Mary does not have a dropper, so she puts four drops worth of blood in a teaspoon and then pours it into the soup. Later, Fred asks if the soup really contains four drops of blood. John says:]
I saw (#each of) the four drops of blood while Mary was making the soup.

This is to be expected if *four drops of blood* is I/M-ambiguous, and (9) induces an II of the predicate while (10) induces an MI. Secondly, notice that while *that* in (11) is acceptable in both (9) and (10), *which* is only acceptable in (9).

(11) Earlier, John inspected the four drops of blood {which/that} Mary {saw/put in the soup.}

Again, this is to be expected if *four drops of blood* is I/M-ambiguous, and if relative clauses headed by *which* presuppose a domain of individuated objects. Applying Rothstein's diagnostics to the numerically modified atomic predicate *four oranges* yields similar results:

(12) [Context: John and Mary are at a party with punch that was decorated using whole, fresh fruit. Now there are only three oranges in the punch, and there is an argument about whether originally there were four. Mary says:]
Before the party started, I saw each of the four oranges that Bill put in the punch.

(13) [Context: John and Mary are at a party, and there is an argument about how many oranges were used to make the punch. Mary was there when Bill made the punch, and saw him measure out four oranges worth of pulp from a store-bought container. She says:]
Before the party started, I saw (#each of) the four oranges that Bill put in the soup.

(14) John wanted to inspect the four oranges {which/that} Bill put in the punch.

Four oranges is acceptable with *each* in the individuating context (12) but not in measure context (13). Similarly, *which* in (14) is acceptable only in the individuating context.

These results show that like the numerically modified atomizer phrase *four drops of blood*, *four oranges* is I/M-ambiguous. However, because neither *drop* nor *orange* denotes a container, unlike e.g. *glass* or *box*, Rothstein's *-ful* suffixation heuristic is not applicable to these nouns. Nevertheless, there is a way of naturally extending Rothstein's diagnostic to include all three categories. We do this in the next section, where we also introduce some novel diagnostics intended to supplement Rothstein's.

2.2. Some Additional Diagnostics

We begin by generalizing Rothstein's *-ful* suffixation diagnostic. Rothstein (2010) proposes that *-ful* transforms a container noun like *glass* into a measure noun, one denoting measured quantities of a substance. We propose that *-ful* is a special case of *worth* in this respect. More generally, *worth* transforms atomic predicates into measure expressions. For example, *four glassfuls of water* and *four glasses worth of water* are synonymous: both denote quantities of water measuring four ad hoc glass-units. Similarly, *four oranges worth of orange* denotes quantities of orange measuring four ad hoc orange-units, while *four grains worth of rice* denotes quantities of rice measuring four ad hoc grain-units. In all three cases, *worth* expresses a relation between substances and their measures. *-ful* also expresses a relation between substances and measures, only that relation is restricted to containment. Hence, *glassful of water* measures how much of a substance would be contained in a certain glass. On the other hand, *worth* is far more liberal with regard to how measures are determined, as shown in (15).

(15)   [Context: John and Mary are planning a dog sledding trip. John is out buying supplies for the trip but can't remember how many dogs they planned to bring. He calls Mary, asking her how much dog food to buy. Mary responds:]
       We need four dogs #(worth) of dog food.

In (15), the function of *worth* is to transform *dog* into a measure noun, one measuring how much dog food a certain dog can eat for the duration of John and Mary's trip.

Thus, our first diagnostic is a natural extension of Rothstein's *-ful* diagnostic: I/M-ambiguous phrases are acceptable with *worth* in measure contexts but not individuating contexts. This is illustrated by (18), which is odd in the individuating context (16) but acceptable in the measure context (17).

(16)   [Context: Mary has made some punch for the party. She wants to decorate it, and she thinks floating fruit would look nice. She places a few apples, some pears, and four oranges in the punch. John asks 'How many oranges did Mary put in the punch?'. Fred replies:]

(17)   [Context: Mary is making punch for the party. The recipe calls for four processed oranges, but Mary is out of oranges. She pours a certain amount of prepackaged orange pulp into the punch, estimating that it is roughly equal to how much orange pulp four typical oranges would produce. John asks 'How many oranges did Mary put in the punch?'. Fred replies:]

(18)   Mary put four oranges worth (of orange) in the punch.

This result makes sense if *four oranges* is I/M ambiguous, if *worth* in (18) transforms *orange* into a measure noun, thus resulting in an MI, and if an utterance of (18) implicates that what was put in the punch was something other than individual oranges, like e.g. orange pulp.

Our second diagnostic involves the nouns *number* and *amount*. Scontras (2014) calls *amount* a DEGREE NOUN. It denotes a relation between kinds and degrees, specifically between instances of a kind and measures of those instances. For example, *amount* in (19a) denotes a relation between a certain group of apples and their collective weight, their cardinality, or some other contextually salient measure.

(19)   [Context: Pointing at four 1 lb. apples in a bowl.]
   a.   John ate that amount of apples every day for a year.
   b.   John ate that number of apples every day for a year.

(19a) is ambiguous: it can mean that every day for a year John ate apples whose collective weight equals four pounds, or else that every day for a year John ate a total of four apples, regardless of their weight. On the other hand, (19b) can only mean the latter. That's plausibly because *number* is a special case of *amount*: it too is a degree noun, but it relates pluralities to their cardinalities.

This difference between *amount* and *number* can be used to demonstrate I/M ambiguities. Notice that (20a) is true in the context given, unlike (20b).

(20)   [Context: Mary places four glasses filled with water in her soup. John places eight glasses filled with water in his soup. John's glasses are exactly half the size of Mary's.]
   a.   There are four glasses of water in Mary's soup, and there's the same amount of water in John's soup.   (true)
   b.   There are four glasses of water in Mary's soup, and there's the same number #(of glasses) of water in John's soup.   (false)

Again, *four glasses of water* denotes quantities of water measuring four glasses worth on the MI. In (20), *the same amount* anaphorically refers to this abstract measure. Consequently, (20) is true only if the amount of water Mary put in her soup is equal to the amount of water John put in his, which is indeed the case. On the II, *four glasses of water* denotes pluralities of four atomic glasses, each filled with water. In (20b), *the same number* anaphorically refers to this abstract cardinality. Consequently, (20b) will be true only if the number of glasses Mary placed in her soup is equal to the number of glasses placed in his, which is not the case. Now consider (21).

(21) [Context: Mary places four glasses filled with water into her soup. John places four glasses filled with water into his soup. John's glasses are exactly half the size of Mary's.]

    a. There are four glasses of water in Mary's soup, and there's the same amount of water in John's soup.   (false)

    b. There are four glasses of water in Mary's soup, and there's the same number of glasses in John's soup.   (true)

These judgments make sense only if *four glasses of water* receives a MI in (21a) and an II in (21b). That's because there are four glassfuls of water in Mary's soup but not in John's, even though there are just as many glasses filled with water in both soups.[3]

Applying this diagnostic to atomizer phrases such as *four grains of rice* reveals that they too are I/M-ambiguous.

(22) [Context: Mary and John are making soup. Mary adds four grains of rice to her soup. John adds eight grains of rice to his. John's grains are exactly half the size of Mary's.]

    a. There are four grains of rice in Mary's soup, and there's the same amount of rice in John's soup.   (true)

    b. There are four grains of rice in Mary's soup, and there's the same number of grains in John's soup.   (false)

(22a) is true only if *four grains of rice* receives an MI since there are in fact four grains worth of rice in both soups. However, (22b) is false since there are twice as many grains of rice in John's soup. This shows that in (22b), *four grains of rice* gives rise to an II. These conclusions are confirmed by the examples in (23), where the evaluations are reversed. (23a) is false because the volume of rice in John's soup is half of that in Mary's, while (23b) is true because there are just as many rice grains in both soups.

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[3]Greg Scontras (p.c.) proposes that (21a) also has a reading that is true in (21), and likewise for (23a) and (25a) below. While we ourselves have trouble getting this interpretation of (21a), the crucial observation related to defining this diagnostic is that it has false interpretation in the context provided, unlike (21b).

(23)   [Context: Mary and John are making soup. Mary adds four grains of rice to her soup, and John does the same. John's grains are exactly half the size of Mary's.]

    a. There are four grains of rice in Mary's soup, and there's the same amount of rice in John's soup.   (false)

    b. There are four grains of rice in Mary's soup, and there's the same number of grains in John's soup.   (true)

These examples show that numerically modified atomizer phrases, like numerically modified container phrases, are I/M ambiguous. Applying the diagnostic *four oranges* yields similar results:

(24)   [Context: Mary and John are making punch. Mary adds four oranges to her punch. John adds eight oranges to his. John's oranges are exactly half the size of Mary's.]

    a. There are four oranges in Mary's punch, and there's the same amount orange in John's punch.   (true)

    b. There are four oranges in Mary's punch, and there's the same number of oranges in John's punch.   (false)

(25)   [Context: Mary and John are making punch. Mary adds four oranges to her punch. John adds four oranges to his. John's oranges are exactly half the size of Mary's.]

    a. There are four oranges in Mary's punch, and there's the same amount of orange in John's punch.   (false)

    b. There are four oranges in Mary's punch, and there's the same number of oranges in John's punch.   (true)

Our final additional heuristic involves the (un)acceptability of modifiers such as *approximately* and *roughly*, or what Lasersohn (1999) calls SLACK REGULATORS. We illustrate the diagnostic in (26) using a container phrase. The individuating context in (4) and measure context in (5) are repeated for convenience.

(4)   [Context: Mary has a strange way of heating up water for coffee. She fills individual glasses with water and then places those glasses in boiling soup.]

(5)   [Context: Mary is making soup. Following the recipe, she fills a certain glass four times with water, pouring the contents each time into the soup.]

(26)   [Context: John, who was watching Mary the whole time, says:] Mary put approximately four glasses of water in the soup.

John's utterance of (26) is acceptable in the measure context but not the individuating context. That's plausibly thanks to an implicature carried by a use of *approximately*: it implicates that the speaker is unsure whether the amount indicated is the amount which actually obtains. On the MI, Mary's utterance of (26) implicates that for all she knows, the amount of water she poured into the soup is not exactly four glassfuls. This sort of uncertainty is normal with measurement. For instance, whether a given bowl contains exactly four ounces of water is something that we can only know to a certain degree of precision. Most everyday purposes do not require a great deal of precision, and it's only when more precision is required that we need to use slack regulators. However, it is hard see how a use of *approximately* could be appropriate in (26) if an II of *four glasses of water* is intended. After all, Mary just placed the four glasses in the soup, and so there would appear to be little room left for uncertainty concerning their exact cardinality. Thus, I/M-ambiguous expressions are generally acceptable with slack regulators on MIs but not IIs, at least when the cardinality is question is relatively small.[4]

In (27), we apply this diagnostic to an example with *four oranges*. The individuating context (16) and measure context (17) are repeated for convenience.

(16)   [Context: Mary has made some punch for the party. She wants to decorate it, and she thinks floating fruit would look nice. She places a few apples, some pears, and four oranges in the punch. John asks 'How many oranges did Mary put in the punch?'. Fred replies:]

(17)   [Context: Mary is making punch for the party. The recipe calls for four processed oranges, but Mary is out of oranges. She pours a certain amount of prepackaged orange pulp into the punch, estimating that it is roughly equal to how much orange pulp four typical oranges would produce. John asks 'How many oranges did Mary put in the punch?'. Fred replies:]

(27)   Mary put approximately four oranges in the punch.

Fred's utterance of (27) is acceptable in the measure context but not the individuating context. This result is predicted if *four oranges* is I/M ambiguous, and if slack regulators are generally acceptable only with MIs in the case of small numbers.

Taken together, the examples in §2 show that I/M ambiguities are not limited to just container nouns. Atomic nouns are in general I/M-ambiguous. In the next section, we argue that this is because a type-shifting principle we call "the Universal Measurer" shifts atomic predicates to measure expressions, thus resulting in MIs.

3. The Universal Measurer

Perhaps because of the tendency to focus on container phrases, some previous analyses of I/M ambiguities have located their source in features peculiar to the meanings of container nouns.

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[4]Slack regulators are generally acceptable with IIs involving large cardinalities, where an exact measure is not so easily determined. It is for this reason that we use only small numbers when diagnosing I/M ambiguities.

Consider for instance the analyses of Rothstein (2009, 2010) and Scontras (2014). They claim that *glass* is by default a monadic predicate true of glasses, i.e. (28a), which can then be shifted into a relational noun either via the CONSTRUCT STATE SHIFT (CSS), a type-shifting operation proposed by Rothstein in her discussion of the Hebrew construct state, or else via a similar meaning Scontras attributes to *of*.

(28) a. $[\![\text{glass}]\!] = \lambda x.\, \texttt{glass}(x)$
      b. $\lambda P.\lambda Q.\lambda x.\exists y.\, P(x) \land Q(y) \land R(x,y)$ (CSS)
      c. CSS($[\![\text{glass}]\!]$) $= \lambda Q.\lambda x.\exists y.\, \texttt{glass}(x) \land Q(y) \land R(x,y)$
      d. CSS($[\![\text{glass}]\!]$)($[\![\text{of water}]\!]$) $= \lambda x.\exists y.\, \texttt{glass}(x) \land \texttt{water}(y) \land R(x,y)$

The relation variable R in (28c) is free because its value is supplied by context. In the case of container phrases like *glass of water*, R is naturally interpreted as the relation of containment, or being filled with (c.f. Partee and Borschev 2012) Thus, as demonstrated in (28d), applying CSS to *glass* and combining the result with *of water* returns a predicate true of glasses filled with water. This predicate can then combine with a cardinality modifier such as the one in (29c), where '$\mu_\#$' is a cardinality measure measuring the number of atoms constituting a plurality.[5]

(29) a. $[\![\text{four}]\!] = 4$
      b. $[\![\text{CARD}]\!] = \lambda n.\lambda P.\lambda x.\, \mu_\#(x) = 4 \land P(x)$
      c. $[\![\text{CARD}]\!]([\![\text{four}]\!]) = \lambda P.\lambda x.\, \mu_\#(x) = 4 \land P(x)$
      d. $[\![\text{four glasses of water}]\!] = \lambda x.\exists y.\, \mu_\#(x) = 4 \land \texttt{glasses}(x) \land \texttt{water}(y) \land R(x,y)$

The result is the the meaning of *four glasses of water* in (29d), a predicate true of those pluralities consisting of four atomic glasses, each of which is filled with water, thus leading to an II.

The MI is said to result from *glass* taking on the meaning of *glassful*. This is given in (30b), where 'μ_{glass}' is an ad hoc glass-measure; it measures how much a given quantity of some substance, e.g. water, would fill a certain glass.

(30) a. $[\![\text{-ful}]\!] = \lambda P.\lambda Q.\lambda n.\lambda x.\, Q(x) \land \mu_P(x) = n$
      b. $[\![\text{glassful}]\!] = \lambda Q.\lambda n.\lambda x.\, Q(x) \land \mu_{glass}(x) = n$
      c. $[\![\text{glassful of water}]\!] = \lambda n.\lambda x.\, \texttt{water}(x) \land \mu_{glass}(x) = n$
      d. $[\![\text{four glassfuls of water}]\!] = \lambda x.\, \texttt{water}(x) \land \mu_{glass}(x) = 4$

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[5]As (29a) suggests, we assume that *four* is a numeral referring to the number four. There are numerous proposals available in the literature for getting from this numeral denotation to the cardinality modifier in (29c). Following Kennedy (2013), we assume for convenience that it results from combining with something like CARD in (29b).

In effect, adding *-ful* to a container noun like *glass* transforms it into a measure noun, one denoting quantities of a substance measuring a certain amount in terms of an ad hoc glass-unit. Consequently, *four glassfuls of water* will denote those quantities of water measuring four glassfuls, i.e. those whose volume is equal to the amount of water which would result from filling a certain glass four times. On the analyses in question, the MI of *four glasses of water* results from combining the default, atomic meaning of *glass* given in (28a) with the meaning of *-ful* given in (30a), perhaps through a process of silent *-ful* suffixation (Scontras 2014:80-81; Rothstein 2010:32).

Though these analyses account for I/M ambiguities in container phrases, in their current form they do not account for examples with atomizer nouns or ordinary count nouns. Since the latter do not denote containers, they have the wrong sort of meaning to combine with *-ful*, either overtly or covertly. Nevertheless, these analyses can be extended to account for the generalization that I/M-ambiguities hold for various atomic predicates. We show how in what follows.

3.1. The semantics of measure nouns

We take as our starting point Scontras' semantics for measure nouns, which itself presupposes the broadly "Neo-Carlsonian" perspective of Chierchia (1998). For our purposes, at least, the important fact about Chierchia's semantics is that there is a systematic correspondence holding between KINDS, or the referents of bare mass and plural nouns, their instances, and corresponding properties. This is related to the well-known fact that bare nouns have both referential and predicative uses, as shown in (31). Chierchia (1998:350-1) relates the meanings involved in these different uses via the two operators in (32), where '$\sqsubseteq$' is a mereological relation.

(31)   a.   Water is widespread.
        b.   Mary drank (some) water.

(32)   a.   For any property P and world w, $^{\cap}P = \lambda w'.\, \iota x[P_{w'}(x)]$, if defined
        b.   For any kind k and world w, $^{\cup}k = \lambda x.\, x \sqsubseteq k_w$, if defined

In (31a), *water* refers to the water-kind, but in (31b) it denotes a predicate true of quantities of water. Chierchia relates the two by analyzing kinds as individual concepts, i.e. functions from worlds to the maximal sum of instances of that kind in that world. For example, the water-kind $\mathbb{W}$ is a function that takes a world to the maximal sum of quantities of water in that world. Applying the $^{\cup}$-operator to $\mathbb{W}$ returns the set of all quantities of water in a world, thus providing a suitable denotation for predicative uses of *water* like (31b). Conversely, applying the $^{\cap}$-operator to the corresponding property nominalizes it, thus returning the original kind.

On Scontras' semantics, measure nouns make it possible to measure instances of a kind. For instance, *ounce* denotes a relation between a kind k and a number n such that instances of k measure n-ounces. This is the meaning given in (33), where 'μ_{oz}' is an ounce-measure.

(33)   a. $[\![\text{ounce}]\!] = \lambda k.\lambda n.\lambda x.\ ^\cup k(x) \wedge \mu_{oz}(x) = n$
       b. $[\![\text{ounce of water}]\!] = \lambda n.\lambda x.\ ^\cup \mathtt{W}(x) \wedge \mu_{oz}(x) = n$
       c. $[\![\text{four ounces of water}]\!] = \lambda x.\ ^\cup \mathtt{W}(x) \wedge \mu_{oz}(x) = 4$

According to (33c), *four ounces of water* denotes those quantities of water measuring four ounces. In the next section, we'll show how adopting UM makes it possible to derive similar sorts of MIs for *four glasses of water*, *four grains of rice*, and *four oranges*.

3.2. The Universal Measurer

We begin with IIs. Following Ladusaw (1982), we assume that *of* denotes a mereological relation, as in (34a). Since this relates two individuals of type $\langle e \rangle$ but kinds are individual concepts of type $\langle s, e \rangle$, it follows that combining *of* with the bare mass noun *water* creates a type-mismatch. However, this is easily remedied by applying Montague (1974)'s extensionalizing $^\vee$-operator, which when applied to a kind returns the maximal sum of the corresponding substance in the world of evaluation. For example, applying $^\vee$ to the kind $\mathtt{W}$ returns the maximal sum of actual quantities of water. Consequently, this has the appropriate type to combine with *of*, namely $\langle e \rangle$. The result is the denotation for *of water* given in (34b), namely the set of all parts of the maximal quantity of water, or more simply the set of all quantities of water.

(34)   a. $[\![\text{of}]\!] = \lambda x, y.\ y \sqsubseteq x$
       b. $[\![\text{of water}]\!] = \lambda x.\ y \sqsubseteq\ ^\vee \mathtt{W}$

Following Rothstein, we assume that IIs for container phrases such as *four glasses of water* arise from applying CSS to the meaning of *glass* and combining the result with the denotation of *of water* in (34b), thus yielding (35a). Since glasses are atomic individuals, the predicate in (35a) can combine with a cardinality modifier such as (29a) to return a predicate true of pluralities consisting of a certain number of glasses filled with water, ultimately resulting in (35b).

(35)   a. $\text{CSS}([\![\text{glass}]\!])([\![\text{of water}]\!]) = \lambda x.\exists y.\ \mathtt{glass}(x) \wedge y \sqsubseteq\ ^\vee \mathtt{W} \wedge R(x, y)$
       b. $[\![\text{four glasses of water}]\!] = \lambda x.\exists y.\ \mu_{\#}(x) = 4 \wedge \mathtt{glasses}(x) \wedge y \sqsubseteq\ ^\vee \mathtt{W} \wedge R(x, y)$

Consequently, *Mary put four glasses of water in the soup* is true if there is a plurality of four glasses, each of which was filled with water and put in the soup by Mary. This is the II.

For MIs, we assume that there is a general type-shifting principle – "the Universal Measurer" – which shifts the meaning of an atomic predicate to that of a measure expression specifically within measure contexts.[6] For instance, UM shifts *glass* into a measure noun which can then compose with the meanings of *of water* and *four* given above.[7]

(36)   a. $\lambda P.\lambda k.\lambda n.\lambda x.\,^{\cup}k(x) \wedge \mu_P(x) = n$ (UM)

        b. $\text{UM}([\![\text{glass}]\!]) = \lambda k.\lambda n.\lambda x.\,^{\cup}k(x) \wedge \mu_{glass}(x) = n$

        c. $\text{UM}([\![\text{glass}]\!])([\![\text{of water}]\!]) = \lambda n.\lambda x.\,^{\cup}[^{\cap}\lambda y.\, y \sqsubseteq\, ^{\vee}\text{W}](x) \wedge \mu_{glass}(x) = n$

        d. $[\![\text{four glasses of water}]\!] = \lambda x.\,^{\cup}[^{\cap}\lambda y.\, y \sqsubseteq\, ^{\vee}\text{W}](x) \wedge \mu_{glass}(x) = 4$

According to (36d), *four glasses of water* denotes those quantities of water measuring four ad hoc glass-units, and so *Mary put four glasses of water in the soup* will be true if Mary put an amount of water in the soup equal to four glasses worth. This is the MI.

The crucial difference between this analysis and previous approaches lies in the potential generality of UM. Nothing in the definition of UM, which we hypothesize is lexicalized as *worth*, restricts its application to just those nouns expressing containment relations.[8,9] As a result, UM can apply to various sorts of atomic predicates. However, one significant problem with this suggestion is that, as stated, UM is not sufficient to derive MIs for *four grains of rice* or *four oranges*. Its first argument – P – is a monadic predicate which is transformed into a measure expression. However, unlike container nouns, atomizers such as *grain* are inherently relational (Scontras 2014). Consequently, they have the wrong type to function as ad hoc measures. Furthermore, on the MI of *four oranges*, the substance measured – orange – is necessarily of the same kind as the ad hoc unit of measurement – an orange. Yet nothing in (36a) guarantees that the measure argument – P – and the substance argument – k – are of the same kind, and with good reason. After all, if that were generally the case, then UM would not suffice to derive the MI of e.g. *four glasses of water*.

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[6]See Barker (1998) for arguments that this kind of type-shifting is generally available and necessary.

[7]Note that although *of water* supplies the kind argument of (36b), it denotes a predicate, not a kind. This mismatch triggers the application of $^{\cap}$ to the predicate $\lambda y.\, y \sqsubseteq\, ^{\vee}\text{W}$, which results in a kind.

[8]The relationship between UM and *worth* may not be quite so straightforward, however, because the two have different distributions. Specifically, there are times when *worth* is obligatory. For example, *four dogs worth of dog food* is acceptable in (15) but #*four dogs of dog food* is not. One possibility is that UM restricts the way in which the ad hoc measure is determined to "natural" relations (Vikner and Jensen 2002) between the individual determining the unit of measure and the substance measured, allowing for containment in the case of container nouns and material constitution in the case of ordinary count nouns (as in e.g. *four oranges [worth of orange matter]*). On this view, *worth*, UM, and *-ful* create a continuum based on the degree to which the measure relation is lexically restricted. However, in general, more work is needed to understand exactly how UM and *worth* differ with respect to the constraints they place on substances and their measures.

[9]See Schwarzchild 2002 for the related idea that *worth* denotes a "scale function" used in measuring.

Our proposed solution to both problems involves "reflexivizing" UM. To do that, we adapt a simplified version of a common approach to analyzing transitive verbs such as *bathe* in (37a), which, when made intransitive, are necessarily reflexive.

(37) a. John bathed the baby.

   b. John bathed.

(37b) cannot mean that John bathed just anyone; it can only mean that he bathed himself. A common explanation posits an operation that transforms a transitive verb into a intransitive, reflexive verb (see Reinhart and Siloni 2005 and references therein). This operation is represented in (38a) as "VREF".

(38) a. $\lambda R.\lambda x.\, R(x,x)$ (VREF)
   b. $\text{VREF}(\llbracket \text{bathe} \rrbracket) = \lambda x.\, \texttt{bathe}(x,x)$

By setting both arguments of the verb to be identical, VREF effectively guarantees that intransitive uses of e.g. *bathe* are reflexive.

We assume that VREF is a special case of a more general reflexivization operation which takes relational expressions of various types and returns reflexivized versions of those expressions. One particular instantiation of this principle is "REFL" in (39a), where $\mathfrak{Q}$ has the same type as UM.

(39) a. $\lambda\mathfrak{Q}.\lambda P.\lambda n.\lambda x.\mathfrak{Q}(P)(P)(n)(x)$ (REFL)
   b. $\text{REFL}(\text{UM}) = \lambda P.\lambda n.\lambda x.\, {}^{\cup\cap}P(x) \wedge \mu_P(x) = n$ (RUM)

In effect, applying REFL to UM resets the first two arguments of UM to be identical, leaving the last two arguments intact. Note that since UM takes a kind as its second argument, applying REFL to UM leads to a type-mismatch. This is remedied by applying Chierchia's $^{\cap}$-operator to the predicate, thus returning a kind $^{\cap}P$. The latter is of the same sort as the ad hoc measure μ_P, as desired. The result is THE REFLEXIVIZED UNIVERSAL MEASURER (RUM) stated in (39b).

We propose that MIs of *four oranges* and *four grains of rice* result from applying RUM to the default denotations of *oranges* and *grains of rice*, as shown in e.g. (40b).

(40) a. Mary put four oranges in the punch.

   b. $\text{RUM}(\llbracket \text{oranges} \rrbracket) = \lambda n.\lambda x.\, {}^{\cup}[{}^{\cap}\lambda y.\, \texttt{oranges}(y)](x) \wedge \mu_{orange}(x) = n$

   c. $\text{RUM}(\llbracket \text{oranges} \rrbracket)(\llbracket \text{four} \rrbracket) = \lambda x.\, {}^{\cup}[{}^{\cap}\lambda y.\, \texttt{oranges}(y)](x) \wedge \mu_{orange}(x) = 4$

According to (40c), *four oranges* denotes those quantities of orange measuring four ad hoc orange-units, and so (40a) will be true just in case the amount of orange Mary put in the punch equals four oranges worth.[10] And this, of course, is the desired MI.

MIs for atomizer phrases can be derived similarly. On Scontras' semantics for atomizer nouns, *grain* partitions the rice-kind into countable, atomic grains. Assuming a denotation for *of rice* similar to *of water* from above, combining (41b) with the former creates another type-mismatch resolvable by applying Chierchia's kind-forming operator $^\cap$. Combining (41b) with this kind results in (41c), or the set of rice grains, where R names the rice-kind. Finally, applying RUM to this set yields a measure of rice given in terms of an ad hoc grain-of-rice-unit, or (41d).

(41)   a. Mary put four grains of rice in the soup.

   b. ⟦grain⟧ = $\lambda k.\lambda x.\ x \in \pi_{grain}(k)$

   c. ⟦grain of rice⟧ = $\lambda x.\ x \in \pi_{grain}(^\cap\lambda y.\ y \sqsubseteq\ ^\vee R)$

   d. RUM(⟦grains of rice⟧) = $\lambda n.\lambda x.\ ^\cup[^\cap\lambda y.\ \texttt{grains-of-rice}(y)](x)\ \wedge$
      $\mu_{grain-of-rice}(x) = n$

As a result, *four grains of rice* denotes those quantities of rice measuring four grains worth, and so (41a) is true just in case Mary put an amount of rice equal to four grains worth in the soup, or the desired MI.

In sum, positing UM allows us to account for the fact that all atomic predicates, not just container nouns, are I/M-ambiguous. One important prediction of this approach is that UM applies not just to individual lexical items but also to phrasal constituents. The same holds for *worth*. It too can take phrasal arguments, as witnessed by e.g. *Mary put 500 grains of rice but only 400 grains of rice worth of water in the pot, so we'll need more water.*

4. Conclusion

In this paper, we have proposed an account of the novel empirical generalization that atomic predicates generally, including atomizers and container nouns, give rise to I/M ambiguities, unlike measure nouns. We argued that these ambiguities arise due to a universally available type-shifting operation, the Universal Measurer. It shifts the meaning of an atomic predicate to that of a strictly quantized predicate. Crucially, this shift in meaning is unidirectional. Since UM does not have an inverse, and since MIs only arise thanks to an application of UM, it is in general impossible to recover IIs from MIs. Similarly, because measure nouns denote standardized measures of substances by default, they generally fail to give rise to IIs.

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[10]Note that in the system of Chierchia (1998), mass nouns qua predicates denote the closure of atoms plus all pluralities formed from them. On the other hand, plural nouns like *oranges* strictly denote pluralities. Consequently, $^\cup[^\cap\lambda y.\ \texttt{oranges}(y)]$ effectively massifies the plural predicate, as Chierchia points out.

Though the discussion here has focused only on the nominal domain, we expect our analysis to apply to atomic predicates across all domains, just as certain influential analyses of the mass/count distinction apply across multiple domains (Bach 1986, Krifka 1989, Zwarts 2005). For instance, consider the verbal predicate *flew for four days* in (42a), which is also plausibly ambiguous between the II suggested in (42b) and the MI in (42c).

(42) a. Mary flew for four days.
      b. There's a group of four days x such that Mary flew on each of x (II)
      c. There's an interval of time x s.t. x measures 96 hours and Mary flew for x.   (MI)

For the II, imagine that Mary has a private plane. On some days, she flies to work, and on other days, she drives. The flight is only 30 minutes one way, so each day she flies she gets about an hour of flying time. In this scenario, John can truly utter (42a) to describe Mary's behavior over a given four day period. This is the II of *flew for four days*. For the MI, suppose instead that Mary has had numerous business flights over the past month, each lasting different intervals of time. After calculating the total amount of time Mary has spent flying over the past month, John, who is in charge of reimbursing Mary for her travel costs, truly utters (42a), meaning that Mary flew 96 hours in total over the past month. We leave showing how the analysis of I/M ambiguities sketched here can be extended to account for (42) and similar examples as a task for future research.

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Ordering subjectivity and the absolute/relative distinction[1]

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Abstract. This paper presents the results of an experimental investigation into faultless disagreement effects with the comparative forms of gradable adjectives. It is shown that subjective judgments regarding orderings are possible with a wide range of adjectival predicates, and furthermore that the presence of such subjectivity correlates with the distinction between absolute and relative gradable adjectives. A theory is developed in which both phenomena derive from the formal properties of adjectival measure functions.

Keywords: adjectives, gradability, comparative, measurement, multidimensionality, standard type.

1. Introduction

The data in (1)-(2) illustrate the well-known distinction between **relative** and **absolute** gradable adjectives (Rotstein and Winter, 2004; Kennedy and McNally, 2005; Kennedy, 2007). Members of the relative class such as *tall* and *short* have context- or comparison class-dependent standards, allowing them to occur with *for* phrases, and disallowing composition with endpoint-oriented degree modifiers such as *slightly* and *completely*. Absolute gradable adjectives such as *clean* and *dirty*, by contrast, have scalar maxima or minima as standards, allowing modification with *slightly* and/or *completely*, and resulting in infelicity when modified by a comparison class-setting *for* phrase.

(1)   a.   Anna is tall / short for an 8-year-old.

       b.   ?? The shirt is dirty / clean for a dress shirt.

(2)   a.   ??   Anna is slightly tall / slightly short / completely tall / completely short.

       b.   The shirt is slightly dirty / completely clean.

The data in (3) exemplify another binary subdivision of gradable adjectives, based on the presence or absence of what I will call **ordering subjectivity** (Kennedy, 2013; Bylinina, 2014; McNally and Stojanovic, 2015). A disagreement about which of two individuals is taller or shorter is necessarily factual in nature; only one of the two speakers can have said something correct (3a). But two competent speakers may disagree as to which of two paintings is more beautiful or which of two dishes is tastier, with neither appearing to be at fault (3b,c).

(3)   a.   A: Anna is taller (shorter) than Zoe.   **factual only**
          B: No, Zoe is taller (shorter) than Anna!

    b. A: The Picasso is more beautiful than the Miró.   **faultless**
        B: No, the Miró is more beautiful.

    c. A: The chili is tastier than the soup!   **faultless**
        B: No, the soup is tastier!

The above difference between *tall/short* on the one hand and *beautiful* on the other corresponds to the distinction drawn by Bierwisch (1989) between **dimensional** and **evaluative** adjectives. *Tasty* exemplifies so-called predicates of personal taste (Lasersohn, 2005), which might be considered a subset of the evaluative class. The presence of faultless disagreement in the comparative is only one of the ways in which these two classes of adjectives diverge in their behavior, others involving the nature of the antonymy relationship, the existence of entailments between comparative and positive forms, and the possibility of embedding under the subjective attitude verb *find* (Bierwisch, 1989; Sæbø, 2009; Kennedy, 2013; Bylinina, 2014).

It should be apparent from the above examples that these two classifications overlap. Specifically, *tall*, which is often cited as the paradigm case of a relative gradable adjective, is also the classic example of a dimensional adjective. This leads to the question of how the other subclasses relate to one another. In particular, there has been no discussion of how absolute gradable adjectives pattern with respect the dimensional/evaluative distinction, and in particular the presence or absence of ordering subjectivity. Can two competent speakers disagree faultlessly as to which of two shirts is cleaner/dirtier? Which of two surfaces is flatter/bumpier? Which of two lines is straighter/more curved? If we are to understand the source of subjective judgments regarding comparative statements, it is important to know first of all which adjectives allow this, but intuitions here seem shaky.

In this paper, I report the results of an experimental study which show that ordering subjectivity is far more common than has been previously recognized, and further that the presence or absence of such subjectivity correlates with the nature of the standard invoked by the adjective in its positive form. After discussing issues faced by existing theories in accounting for these facts, I put forward a theory of adjectival meaning according to which the availability of objective versus subjective readings derives from constraints on the measure functions lexicalized by gradable adjectives of various sorts. I further show that these same factors play a role in determining the nature of the standard for the positive form.

2. Experiment: Faultless Disagreement Paradigm

As seen in examples such as (3), when it comes to dimensional adjectives such as *tall* and evaluative adjectives such as *beautiful*, judgments about comparative statements are clear: the former are necessarily objective or fact based, the latter are subjective. But when we extend our focus to a wider range of adjectives, the picture becomes murkier. The present study aims to establish a firmer empirical basis for theoretical work by using a novel faultless disagreement paradigm to diagnose the presence of ordering subjectivity among a wide range of adjective types.

2.1. Methodology and stimuli

The experiment employed a forced choice task in which participants saw brief dialogues of the form in (4)-(6), and were asked to classify the nature of the disagreement between the two speakers. Two response options were given: "only one can be right; the other must be wrong" and "it's a matter of opinion". The first of these was classified as a judgment of 'fact', the second as a judgment of 'opinion'.

(4) A: John and Fred look similar but John is taller than Fred.
   B: No, Fred is the taller one of the two.

(5) A: Look – Tommy's shirt is dirtier than the one his little brother Billy is wearing.
   B: No, Billy's shirt is dirtier than Tommy's.

(6) A: The necklace Susan is wearing today is uglier than the one she had on yesterday.
   B: No, the one she was wearing yesterday was uglier.

A total of 35 gradable adjectives were tested, falling into the following five categories:

- Relative gradable adjectives with numerical measures (**RELNUM**): *tall, short, old, new, expensive*

- Relative gradable adjectives without numerical measures (**RELNO**): *sharp, dull, dark, light, hard, soft*

- Absolute gradable adjectives with totally closed scales (**ABSTOT**): *full, empty*

- Absolute gradable adjectives with partially closed scales (**ABSPART**): *wet, dry, straight, curved, rough, smooth, clean, dirty, salty*

- Adjectives which may be classified as evaluative in a broad sense (**EVAL**): *good, bad, beautiful, pretty, ugly, easy, interesting, boring, tasty, fun, intelligent, happy, sad*

Adjectives were assigned to these categories according to judgments reported in the literature as well as linguistic tests. Relative gradable adjectives were identified as those for which both the adjective and its antonym are acceptable in the frame *x is Adj but y is Adj-er*, and for which neither adjective nor antonym allows modification by *slightly*. Absolute gradable adjectives were identified as those for which either adjective or antonym is infelicitous in the above frame and/or can co-occur with *slightly*. An adjective was considered to have a numerical measure if its comparative form can be modified by a measure phrase.[2] The evaluative category includes adjectives of the sort

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[2]The test was based on the comparative because, as is well known, many adjectives compose with measure phrases in the comparative but do not allow direct measure phrases (e.g. *ten dollars more expensive* vs. **ten dollars expensive*), and as such the comparative provides a better test for the existence of a numerical measurement system. The reasons for the restrictions on direct measure phrases are complex and seemingly idiosyncratic; see Schwarzschild (2005); Sassoon (2010) for discussion.

discussed in the literature under the term 'evaluative' or 'predicates of personal taste'. This is a mixed class, encompassing value, taste and aesthetic judgments, emotion words, and psychological predicates; they are united, and distinguished from the other four categories, in that they do not denote external physical properties. Note finally that the RELNUM category corresponds to the class which in other work has been called dimensional adjectives, a point I will return to below.

The experiment was administered online via Amazon MTurk, with test items split across 4 lists. Each list contained 8-12 test items and 12 fillers. Some adjectives appeared on more than one list, in different item contexts. Fillers were split equally between two types: i) those expected to yield 'opinion' judgments, including vague nominal predicates (e.g. *jerk*), deontic and epistemic modals, statements of likelihood, and moral statements; ii) those expected to yield 'fact' judgments, based on factual statements (example: A: The judge found Frank guilty. B: No, the judge found Frank innocent.). Sample size was 20-25 per list, for a total sample size of $n = 91$. Full stimuli are available at http://www.zas.gwz-berlin.de/fileadmin/mitarbeiter/solt/fault.pdf.

2.2. Results

Results by adjective class and for individual adjectives are displayed in Figure 1. A generalized linear mixed effects model was fitted to the results using the lme4 package (Bates et al., 2014) in R (R Core Team, 2015), with response ('fact' vs. 'opinion') as dependent variable, adjective type as a fixed effect, and random intercept for subject. The effect of adjective class was found to be significant, with post hoc testing via the multcomp package (Hothorn et al., 2008) using Tukey correction for multiple comparison showing all pairwise comparisons to be significant at $p < 0.001$ except RELNO vs. ABSPART ($p < 0.01$) and RELNUM vs. ABSTOT (nonsignificant).

2.3. Discussion and further observations

The first conclusion to be drawn from the present experiment is that ordering subjectivity is widespread, found not only with classic cases of evaluative adjectives such as *beautiful* and *tasty*, as in our original examples, but to some extent for the majority of the adjectives tested.

The second observation that emerges is that in this respect, gradable adjectives divide into not two but three distinct classes. Some allow (almost) exclusively objective or factual readings of the comparative (the RELNUM and ABSTOT classes). Some by contrast are radically subjective in the comparative, eliciting few if any 'fact' judgments (the EVAL class). Finally, some fall in between the two extremes, allowing both objective and subjective readings for the comparative (the RELNO and ABSPART classes); furthermore, among this third group, adjectives range from those that skew towards objective readings to those that skew towards subjective readings.
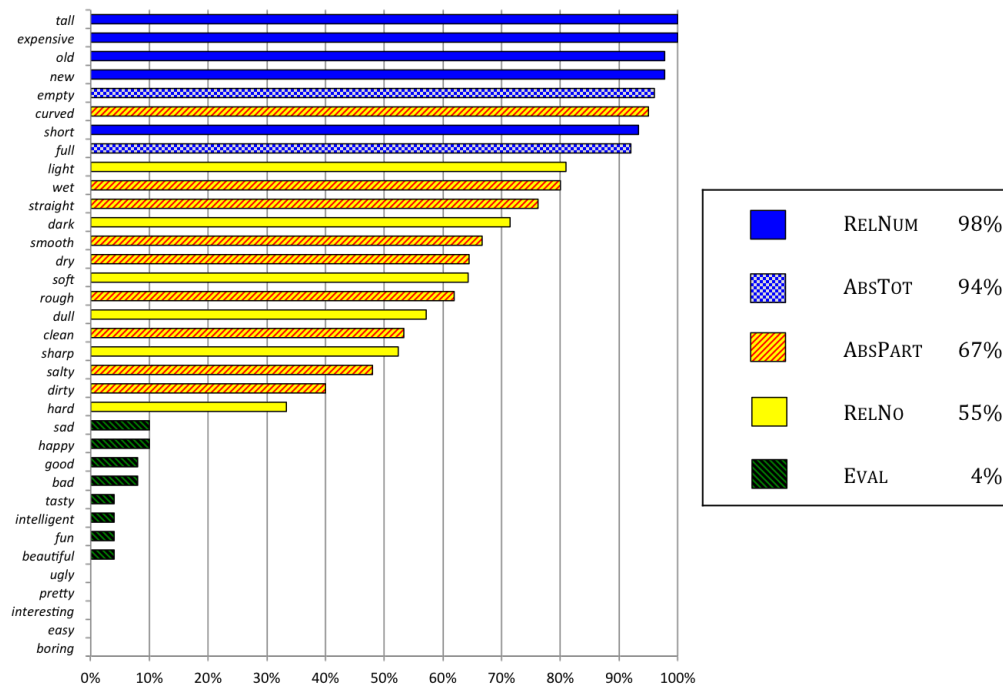
Figure 1: Results of Experiment - Percent 'Fact' Judgments

Looking at the results by adjective class, it seems that we have found a correlation between ordering subjectivity on the one hand and the nature of the standard invoked by the adjective in its positive form on the other. Specifically, purely objective judgments about scalar orderings are restricted to a certain subset of the relative class and the totally closed scale pair *full/empty*. Classic examples of absolute partially closed scale adjectives such as *clean/dirty*, *wet/dry* and *rough/smooth* fall consistently in the mixed class. This is a surprising finding. One of the phenomena under investigation here, the absolute/relative distinction, involves the positive form of the adjective, and has been attributed to the presence or absence of scalar endpoints. The second involves the comparative form, and has to do with the nature of judgments regarding the ordering of individuals along the relevant dimension. There is no obvious *a priori* reason to expect the two to be related.

There is, however, a clear confound here, namely the presence or absence of a system of numerical measurements. It is not relative gradable adjectives as a whole whose comparative forms elicited exclusively objective interpretations, but more specifically those with corresponding units of measure; those without such units, such as *light/dark* and *soft/hard*, patterned with the absolute partially closed scale group. Furthermore, the totally closed scale pair *full/empty* might also be aligned to the class of adjectives with measurement units, in that degrees of fullness or emptiness can be quantified in percentages (e.g. *90% full*). Perhaps it is the availability of a numerical measurement system itself, and not the scale structure of the adjective or the type of standard it has, that is correlated with the possibility of ordering subjectivity. This is a very reasonable idea. In order to assign a numerical degree of 'adjective-ness' to an entity, it must be possible to objec-

tively measure the degree to which that entity has the property in question. Quite plausibly, the same possibility of objective measurement is also responsible for the objective nature of judgments regarding orderings. We might then suspect the apparent correlation with standard type to be an artifact of the experimental design, in that absolute gradable adjectives with measurement units were not included among the stimuli.

Such an explanation, though, is problematic, for a simple reason: putting aside adjectives such as *full/empty* that allow proportional measures, there <u>are</u> virtually no absolute gradable adjectives with numerical measures. Commonly cited examples of the absolute class, such as those in the ABSPART group tested here, lack standard units. Conversely, Schwarzschild (2005) discusses 49 adjectives that allow measure phrases at least in the comparative. Of these, only 4 pattern (in my judgment, using the above-described tests) as absolute: *early/late* (which Schwarzschild argues are covert comparatives), and *intelligent/stupid* (whose status regarding both standard type and numerical measurability is unclear). This is a surprising pattern, which to my knowledge has not been previously observed, and which certainly merits some sort of explanation. The puzzle we are faced with can then be restated as follows: what is the reason for the correlation between objectivity – encompassing both the existence of measurement units and the absence of ordering subjectivity – and the type of standard invoked by the adjective. It is this puzzle that I address in the remainder of the paper.

3. Previous accounts

In this section I briefly review relevant research in three areas relating to ordering subjectivity and the absolute/relative distinction, noting issues they face in accounting for the experimental findings, and highlighting proposals that will form the basis for the account developed below.

3.1. Gradability

The now standard semantic approach to gradability is the degree-based framework of Cresswell (1977); Kennedy (1997); Heim (2000) and others, according to which gradable adjectives lexical-ize measure functions that map individuals to degrees on a scale (7).[3] The comparative can then be analyzed as expressing a relation between the degrees assigned to two individuals, as in (8):

(7) $[\![\text{dirty}]\!] = \lambda d \lambda x . \mu_{DIRTY}(x) \succeq d$

(8)   a.   Tommy's shirt is dirtier than Billy's.

        b. $\mu_{DIRTY}(\text{Tommy's shirt}) \succ \mu_{DIRTY}(\text{Billy's shirt})$

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[3]For concreteness, here and below I adopt the version of the degree-based framework according to which gradable adjectives denote degree relations (Heim, 2000). If desired, the analysis could be restated on the alternate approach on which they have denotations instead as measure functions (Kennedy, 2007).

An unspoken assumption that seems to underlie representations of this form is that for any given adjective *Adj*, there is a unique measure function μ_{Adj}.[4] This is reasonable for adjectives such as *tall*, but problematic for those such as *beautiful* and even *dirty*, for which competent speakers can disagree faultlessly about the relative ordering of two individuals. If we adopt a degree-based framework, it seems we must somehow allow different mappings for different speakers.

The problem that arises with representations such as (8b) derives in part from the tendency to equate dimensions of measurement with the scales that track them. Recently, there have been proposals that do away with such a one-to-one correspondence, allowing instead a one-to-many relation between dimensions and scales. For example, Solt (2016b) argues that quantity dimensions – including even cardinality – can be tracked by multiple scales that differ in their structures, in particular in the strength of the ordering relation $\succ$. In the adjectival domain, Kennedy (2013) proposes that gradable adjectives have core meanings as specifications of dimensions, which can then be mapped to different sorts of scalar predicates. Finally, Sassoon (2010) proposes that the measure functions lexicalized by gradable adjectives are not fully specified but rather indexed to contexts or worlds, with two contexts/worlds potentially differing in the degrees that are assigned to individuals even when the physical properties of objects remain the same. Below, this will be taken as one of the building blocks for an account of ordering subjectivity.

3.2. Subjectivity

There is a sizable body of research on adjectival subjectivity or 'judge-dependence' (see Laser-sohn 2005; Stephenson 2007 and other work cited below), focusing in particular on predicates of personal taste such as *tasty* and *fun*, which provide the best-known examples of faultless disagreement: when two speakers disagree as to whether or not a dish is tasty or an experience is fun, the disagreement appears to be a real one, yet neither speaker seems to have said something incorrect or false. Recently it has been observed that subjectivity of this sort is found with a much wider range of adjectives beyond obvious personal taste predicates, in particular occurring also with the positive forms of vague gradable adjectives such as *tall*: two speakers may disagree faultlessly as to whether an individual is tall, perhaps because they have in mind different thresholds or standards (Kennedy, 2013; Bylinina, 2014). These same authors have also observed that the subjective interpretation of comparative forms – that is, ordering subjectivity – is a more restricted phenomenon, occurring with only some types of gradable adjectives (cf. (3)).

There are two leading semantic approaches to subjectivity. The relativist analysis (Lasersohn, 2005) includes a judge parameter to the index of interpretation, along with the usual time and world

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[4]As stated, this is not entirely correct, in that certain adjectives are obviously ambiguous as to dimension; *long*, for instance, has both spatial and temporal interpretations, and *light* can reference either weight or brightness. What seems largely assumed, however, is that once the dimension is fixed, so too is the scale and measure function.

parameters (9a). The contextualist approach (Stojanovic, 2007; Sæbø, 2009), by contrast, assumes that predicates of this sort feature an additional judge or experiencer argument (9b). Elaborations on and combinations of these two approaches are found in Stephenson (2007), Pearson (2013), and Bylinina (2014), among others.

(9)   a. $[\![\text{tasty}]\!]^{w,t,j} = \lambda x.x$ tastes good to j in w at t
      b. $[\![\text{tasty}]\!]^{w,t} = \lambda y \lambda x.x$ tastes good to y in w at t

Importantly, in the form shown here, neither of these approaches accounts for ordering subjectivity. Although *tasty* is gradable, the above analyses localize subjectivity at the level of the positive form, thus providing no explanation for subjective judgments regarding scalar orderings. Minimally, then, it seems that measure functions such as those in (7) must also be indexed or relativized to judges. Nor do we have an explanation for our experimental finding that adjectives exhibiting ordering subjectivity fall into two classes, depending on whether or not they also allow objective readings for the comparative.

A perhaps deeper issue is that for at least some of the adjectives we have considered, ordering subjectivity does not appear to be restricted to differences in perspective between speakers; rather, it seems that a single speaker's judgments with respect to orderings are potentially uncertain or variable. Consider for example two shirts, one which is clean except for a grass stain on the sleeve, while the other is slightly dingy overall. Which one do I consider dirtier, and which cleaner? I think my answer has to be to be 'it depends' – on what type of shirt and how it will be used, on what sort of dirt we are most concerned about, and so forth. The same might be said, for example, regarding which of two roads is bumpier, or which of two fences is straighter. Formally, subjectivity of this sort cannot be modeled in terms of variation in a judge parameter.

In recent work that has explicitly discussed ordering subjectivity, the intuition is put forward that it derives from the multidimensionality of the properties in question (see especially Kennedy, 2013; McNally and Stojanovic, 2015). Whereas the attribution of a predicate such as *tall* is dependent on a single dimension, namely height, that of a predicate such as *healthy* or *beautiful* depends on multiple underlying dimensions. Subjectivity of the sort considered here arises when there is uncertainty or potential disagreement as to the component dimensions and how they should be integrated. For example, two speakers might disagree about which of two individuals is healthier because they disagree about which aspects of health should carry more weight.

The above authors do not attempt to formalize this insight. However, a comprehensive semantic theory of adjectival multidimensionality is developed by Sassoon (2013 and other work), and further extended by Bylinina (2014), who in particular applies it to the subjectivity of evaluative adjectives such as *intelligent*. Below I will build on this further to account for the pattern of results from the present experiment.

3.3. Standard type

The final topic of interest to us here involves the distinction between absolute and relative gradable adjectives. As already alluded to, the leading account of this difference relates the interpretation of the positive form of the adjective to the structure of the scale it lexicalizes (Kennedy and McNally, 2005; Kennedy, 2007). When the scale is closed on one or both ends, the scalar minimum or maximum serves as the threshold or standard of application for the positive form. To be clean, for example, is to have a maximal degree of cleanness, while to be dirty is to have a more-than-minimum degree of dirtiness. When the scale is open on both ends, the standard is instead contextually determined, perhaps with reference to a comparison class. Thus to be tall is to have a degree of height greater than some contextually salient threshold, dependent in some way on the sort of entities under consideration. Kennedy proposes that this pattern derives from a Principle of Interpretive Economy, which calls for maximizing the semantic contribution of conventional linguistic elements such as scalar endpoints.

The scale-based account is elegant and highly explanatory, but leaves open the question of what determines the structure of the scale underlying the adjective's meaning. For example, why is dirtiness analyzed as having a lower-closed scale but height an open scale, given that both intuitively have a zero point? Work in this tradition has also not recognized the connection between standard type and objectivity/subjectivity that was uncovered in the present experiment.

A number of authors have proposed to derive the absolute/relative distinction in a principled manner from more basic factors, and certain of these proposals provide a starting point to addressing the latter issue. Toledo and Sassoon (2011) and Sassoon (2012) relate the difference between the two subclasses to the sort of comparison class they reference: for relative gradable adjectives, the comparison class is an extensional category of individuals, while for absolute gradable adjectives, it is made up of counterparts or temporal stages of the same individual. This derives from a more basic distinction in denotations: relative gradable adjectives such as *tall/short* are individual level predicates (Carlson, 1977), denoting stable, enduring properties, while their absolute counterparts such as *clean/dirty* are stage-level predicates, denoting temporally variable properties. The difference in standard type can then be related to how items in the two sorts of comparison classes are distributed. Counterpart comparison classes typically have a salient maximum and/or minimum element (e.g. the shirt in its state of complete cleanness), which provide the basis for an endpoint standard. Extensional comparison classes do not. Even further, in the case of adjectives such as *tall* that denote stable properties, mapping of comparison class members to the scalar zero does not occur, in that anything whose height we can inquire about has non-zero height. A scalar minimum would thus be a trivial standard, and therefore a relative standard emerges instead.

Interestingly, a very similar insight is expressed in a quite different framework by Lassiter and Goodman (2013) and Qing and Franke (2014), who develop related pragmatic analyses in which the thresholds for gradable adjectives are modeled probabilistically as functions of the assumed prior distribution of entities in the comparison class with respect to the relevant dimension. A

context-dependent relative standard emerges when a normal-like prior is assumed; an absolute standard arises when there is sufficient probability density at one of the scalar endpoints.

Here I will not adopt either of these accounts in the form described above. Rather, the central insight that I will draw on is that to understand the source of an adjective's standard type, it is necessary to consider the the possible values to which members of the domain may be mapped, with particular reference to potential triviality of standards.

4. Accounting for Ordering Subjectivity

Bierwisch (1989) proposes that gradability derives from a mental operation of comparing individuals: "there is no degree without comparison and no comparison without degree" (p. 112). If this is indeed so, namely that degrees originate in a speaker-internal psychological process, we might wonder why it is not the case that <u>all</u> comparative statements are subjective. The reason, I will argue, is that for some dimensions we can impose a structure on the domain through which speakers' judgments are necessarily aligned.

We may formalize this using concepts from measurement theory (see Kranz et al. 1971 for a basic introduction to measurement theory and Sassoon 2010 and Lassiter 2011 for linguistic applications). We begin with a domain Dom and a binary relation R on Dom reflecting some dimension of measurement, where R has the properties of a strict weak order (a relation that is irreflexive, asymmetric, transitive and transitive with respect to incomparability). Measure functions and scales are then defined as follows:

(10) A **measure function** is a function $\mu_{DIM} : Dom \rightarrow S$ from Dom to some scale $S = \langle D, \succ, DIM \rangle$, where
  - DIM is the dimension of measurement
  - D is a set of degrees
  - $\succ$ is an ordering relation on D
  - $\forall a, b \in Dom, \mu_{DIM}(a) \succ \mu_{DIM}(b)$ iff aRb

As discussed above, this formalization has the effect of establishing a one-to-many rather than one-to-one relation between dimensions of measurement and the scales that track them.

We then adopt the previously discussed proposal of Sassoon (2010), according to which gradable adjectives are underspecified, lexicalizing not a single measure function but a family of functions indexed to contexts c. As on her account, I assume that two contexts c and c' may differ in the measures assigned to individuals, even if the physical properties of objects remain the same. Thus the general template for gradable adjective meaning is the following:

(11) $[\![\text{Adj}]\!]^c = \lambda d \lambda x . \mu_{DIM}^c(x) \succeq d$

To put this differently, gradable adjectives on this view lexicalize dimensions rather than particular scales. The presence or absence of ordering subjectivity can then be related to the further constraints on the set of measure functions μ_{DIM}^c encoded by the adjective.

4.1. Sources of objectivity

I propose that objective judgments regarding orderings arise when μ_{DIM}^c is such that it allows a principled, order-preserving mapping to the real numbers. This has the effect of externalizing orderings of individuals, aligning them across speakers and contexts to the fixed order of the number line. Such a mapping can come about in various ways.

a) Additive measure functions. An important class of measure functions is made up of those that are additive with respect to concatenation, meaning that the measure assigned to two individuals concatenated in the relevant way is the sum of their two individual measures. Height is a classic example: the height of two individuals stacked one on top of the other is the sum of their individual heights. Other dimensions with this property include weight, depth, width, length, volume, duration and arguably cost (while items are often cheaper if purchased in quantity, the fact that we recognize this as a discount is an indication that we perceive cost as inherently additive).

Additivity may be encoded via a constraint on the family of measure functions lexicalized by an adjective. We define a concatenation operation $\oplus$ on elements of the domain, and a corresponding addition operation $+$ on degrees on the scale. The constraint is then that in (12), where C is the set of possible contexts; a sample denotation for an adjective satisfying this constraint is (13).

(12)   **Additivity constraint:**
       $\forall a, b \in Dom$ and $c \in C$, $\mu_{DIM}^c(a \oplus b) = \mu_{DIM}^c(a) + \mu_{DIM}^c(b)$

(13) $[\![\text{tall}]\!]^c = \lambda d \lambda x. \mu_{HEIGHT}^c(x) \succeq d$,
       where $\forall c \in C$ and $a, b \in Dom$, $\mu_{HEIGHT}^c(a \oplus b) = \mu_{HEIGHT}^c(a) + \mu_{HEIGHT}^c(b)$

A scalar mapping satisfying additivity is a ratio scale. Such a scale can be given a numerical representation via a further structure-preserving mapping to the real numbers under ordinary addition. This allows the establishment of numerical measures, if some standard object is selected as the basis for a unit of measurement (e.g. an object serving as the meter standard). Furthermore, such numerical representations are unique up to multiplication by a positive constant k; this means in particular that the relation between the numerical values assigned to two individuals in one context cannot be reversed in another context. This invariant (up to multiplication) mapping to the number line forms the basis for objective judgments regarding statements about orderings, i.e., comparatives; this is consistent with our experimental findings for the additive-dimension adjectives *tall*, *short* and *expensive*. Thus additivity yields both aspects of objectivity that were discussed above.

A large number of gradable adjectives fall into this class, including most of those that compose with measure phrases (e.g. *wide/narrow*, *heavy/light*, *long/short*); we predict these too would pattern as objective with respect to orderings. But not all dimensions lexicalized by gradable adjectives are additive in the sense of height. Temperature is a prime example (Lassiter, 2011): the temperature of two bowls of soup poured together is not the sum of their two individual temperatures, but rather somewhere intermediate between them. Among adjectives that lexicalize non-additive dimensions, there are nonetheless at least two other possible sources of numerical mappings.

b) 'Natural' units. There are dimensions for which natural, speaker-external phenomena serve as the basis for numerical measurement systems. Two examples of this are time and temperature. In the case of time, the rotation of the earth and its orbit around the sun provide the basis for the units 'day' and 'year'; subdivision and concatenation of these units yield further units such as 'hour', 'minute', and 'week'. For temperature, the freezing and boiling points of water provide two anchor points on the scale, which can then be divided into equal increments, for instance by equal increases in the level of mercury in a thermometer.

Units derived in this way provide another sort of principled mapping from entities to numbers. This of course provides the basis for measure phrases (e.g. *20 years old*, *5 degrees warmer*); on the account proposed here, it also enables objective judgments about orderings. This is in line with our experimental findings for the adjectives *old* and *new* (temperature adjectives were not included in the experiment, but we would predict similar results for them as well).

c) Context-independent derived measure functions. A final set of adjectives that are objective with respect to orderings are those lexicalizing measure functions that can be built up from measure functions of the above two classes in a context-independent way. The dimension of fullness provides a good example: the degree of fullness of a container (say, a bottle or gas tank) can be expressed as the volume of its contents divided by its capacity, i.e., the volume it is able to hold. A half full tank, for example, is one whose contents have half the volume of its capacity.

This class can be defined as adjectives that satisfy the constraint in (14); as an example, the corresponding lexical entry for the adjective *full* is given in (15):

(14)   **Context independent derived function constraint:**
$$\forall c \in C, \ \mu_{DIM}^c(x) = f(\mu_{DIM_1}^c(x), \mu_{DIM_2}^c(x), \ldots \mu_{DIM_n}^c(x)),$$
        where $\mu_{DIM_1}^c, \ \mu_{DIM_2}^c, \ldots \mu_{DIM_n}^c$ are objective measure functions

(15) $[\![\text{full}]\!]^c = \lambda d \lambda x. \mu_{FULLNESS}^c(x) \succeq d,$

        where $\forall c \in C$ and $x \in Dom, \mu_{FULLNESS}^c(x) = \dfrac{\mu_{VOLUME}^c(content(x))}{\mu_{VOLUME}^c(capacity(x))}$

As defined here, fullness is not strictly speaking additive: two half full glasses when placed together do not produce a full glass, though their combined contents are the same as that of a single

full glass. But because degrees of fullness can be derived via a context-independent function of two additive measure functions, a principled mapping to numbers can nonetheless be derived. Thus we may have measure expressions (e.g. *20 % full*), and we correctly predict objective judgments regarding comparative statements (cf. the experimental findings for *full/empty*). Other dimensions in this class might be purity (defined as volume of impurities relative to total volume) and speed (distance traveled divided by duration). As we would expect on the account developed here, the corresponding adjectives allow numerical measures (*90% pure*, *5 kilometers per hour faster/slower*); we predict them also to elicit purely factual judgments of their comparative forms.

4.2. Sources of subjectivity

Having discussed factors that give rise to objective judgments regarding orderings, let us turn now to the nature of the measure functions lexicalized by adjectives whose comparative forms can be interpreted subjectively. Recall that the experiment reported in Section 2 identified two subclasses of such adjectives: those that also allow objective readings for the comparative, and those that do not. Here I propose that this difference corresponds to two distinct sources of ordering subjectivity. This proposal is similar to ones made by Kennedy (2013) and Bylinina (2014), but I will attempt use the experimental findings to shed new light on the relationship between the two factors.

d) Multidimensionality. In Section 3 I discussed the insight that adjectives exhibiting ordering subjectivity are multidimensional. Underspecification in or uncertainty about the component dimensions and how they should be integrated results in the potential for disagreement as to orderings. Take for example the pair *clean/dirty*. Intuitively, the degree of cleanness or dirtiness of an object is a function of the amount and type of dirt on it, perhaps in proportion to its size. But which sorts of dirt (broadly construed) we are concerned with, and how different sorts are weighted relative to one another, are matters of potential disagreement, and there does not seem to be a principled correct choice. On one way of making this more specific, shirt a might work out to be dirtier than shirt b, while on another equally valid choice, the reverse relation might obtain.

To formalize this, I build on Sassoon (2013) and Bylinina (2014) in assuming that adjectives of this sort are associated in each context c with a set of component dimensions $DIM_1^c, DIM_2^c, \ldots,$ DIM_n^c, whose measure functions are integrated by some function f^c. We have already seen something similar in the form of the lexical entry for *full*. But in that case, subjectivity did not arise, because both the component dimensions and the manner of their combination were fully specified. Ordering subjectivity arises when this requirement is relaxed, such that one or both of these components becomes context dependent. (16) specifies the form of such functions, and (17) gives a plausible if undoubtedly overly simplistic entry for *dirty* in this form.

(16)   **Context-dependent derived function constraint:**
       $\forall c \in C, \mu_{DIM}^c(x) = f^c(\mu_{DIM_1^c}^c(x), \mu_{DIM_2^c}^c(x), \ldots \mu_{DIM_n^c}^c(x))$

(17) $[\![\text{dirty}]\!]^c = \lambda d \lambda x. \mu^c_{DIRTINESS}(x) \succeq d,$

where $\forall c \in C$ and $x \in Dom$, $\mu^c_{DIRTINESS}(x) = \frac{\sum_{i=1}^{n} k^c_i \cdot \mu^c_{AMOUNT}(dirt^c_i(x))}{\mu^c_{SIZE}(x)}$

Note that the individual dimensions that underlie such entries may themselves be objectively measurable; subjectivity derives from the potential for variation in the choice of these dimensions and how they are combined. This precludes the creation of a numerical measurement system, and also allows for faultless disagreements regarding comparative statements.

As was seen in Section 2, many of the adjectives that allowed subjective interpretations for the comparative form could also be interpreted objectively (examples being *clean*, *dirty*, *smooth*, *rough*, *sharp* and *dull*). I see two possibilities for how this may arise. The first is that the two entities under comparison are so different with respect to the property in question that for any context $c \in C$, the measure function μ^c_{DIM} returns the same ordering. For example, there may be potential for disagreement as to how precisely dirtiness should be measured, but regardless of how we resolve the underspecification that is responsible for this, a shirt covered with oil stains must be evaluated as dirtier than one that is clean except for a small smudge of dirt near the hem. A second possibility is that subjects who gave 'fact' judgments did so in the belief that for the purposes at hand, there was in fact some correct way to measure, that is, some principled choice of measure function among the family μ^c_{DIM}, even if it may not be known (or knowable) to the speaker.

e) Judge dependence. The reader will note that up to this point, there has been no mention of a judge or experiencer parameter as contributing to ordering subjectivity. This is intentional: as noted earlier, the potential for variability in orderings does not seem limited to differences between speakers, but may persist in the judgments of a single speaker. Such variation is captured by (16), which ties the variation to a difference in contexts rather than specifically judges. We might ask, though, if this is sufficient, given the intuition that faultless disagreements – including disagreements regarding comparative statements – derive from the perspectives of different speakers.

Let us consider here the adjectives identified as purely subjective in the experiment. Among this group, most denote properties whose ascription depends necessarily on what McNally and Stojanovic (2015) refer to as the mediation of a sentient individual. These include value judgments (*good/bad*), aesthetic judgments (*beautiful/ugly*), taste judgments (*tasty*), experiential properties (*interesting/boring*) and internal states (*happy/sad*). These adjectives do not directly describe properties of objects and events in the world, but rather our perceptions of, judgments about and experience with the objective world, and as such, it seems plausible that their dependence on sentient intermediation be represented in their semantics. I thus follow the existing tradition of work on subjectivity in taking these to involve measure functions parameterized to a judge. Adapting for concreteness the relativist approach, we may represent this as follows:

(18) **Judge dependent measure functions:** $[\![\text{Adj}]\!]^{c;j} = \lambda d \lambda x. \mu^{c;j}_{DIM}(x) \succeq d$

(19) $[\![\text{beautiful}]\!]^{c;j} = \lambda d \lambda x. \mu^{c;j}_{BEAUTY}(x) \succeq d$

Importantly, the underspecification in (18)-(19) cannot be resolved in the same way as that in (16)-(17). The situation might be such that we can fix the dimensions and weights that determine an entity's degree of cleanness or dirtiness, resulting in objectivity with respect to orderings; but degrees of beauty as represented here are inherently dependent on the perspective of a judge, which cannot be eliminated. I thus hypothesize that the distinction we found between mixed predicates that allow both subjective and objective interpretations for their comparative forms and purely subjective predicates is largely that the former denote underspecified, multidimensional measure functions, while the latter are judge dependent. In this I differ from Kennedy (2013), who suggests that all types of adjectival subjectivity – including ordering subjectivity – might be reduced to 'dimensional uncertainty'.

To this point, we might ask whether adjectives of the judge-dependent sort should also be represented explicitly as functions of objective measure functions, and as explicitly multidimensional. Plausibly, this varies by adjective. *Salty*, for example, is experiential, but also allows objective readings, perhaps because it (in contrast e.g. to *tasty*) encodes a judge-dependent function of an objective measure function, salt content. And while properties such as beauty, interest and difficulty clearly depend on multiple facets of the external world for their attribution, not all of the corresponding adjectives pass accepted tests for multidimensionality (e.g. *interesting in every respect* vs. ??*tasty in every respect*). Space considerations do not permit me to go into these issues here; I refer the reader to Solt (2016a) for more in-depth discussion.

5. Accounting for Standard Type

In the previous section we saw that the nature of the measure functions lexicalized by a gradable adjective determines the availability of objective versus subjective interpretations of comparative statements. Here I will argue that the same factors play a role in determining the nature of the standard for the adjective's positive form.

My starting point is Sassoon's insight regarding the role of triviality in ruling out a potential scalar endpoint-based standard. Consider for example the dimension of height. Nothing of which we might reasonably predicate *tall* or *short* can have zero height. While a scale of height might itself include a zero point, nothing in the relevant domain will be mapped by the corresponding measure function μ_{HEIGHT} to that point. Thus a scalar zero point would be a trivial standard, in that it would not yield a meaningful partition of the domain; rather, every individual would be evaluated as tall, and none as short.

I propose this to be the general principle guiding the determination of standard type, as follows:

(20)   For an adjective Adj lexicalizing measure functions μ_{DIM}^c, if for every context $c \in C$ there is neither a minimum nor a maximum degree d to which entities $x \in Dom$ may be mapped by μ_{DIM}^c, a relative standard will obtain. Otherwise, an absolute standard will be preferred.

The crucial point is now the following: virtually all dimensions that are additive with respect to concatenation pattern like height in disallowing zero mappings. Nothing whose weight we might ask about can have zero weight; no event whose duration might be at issue can have zero duration; and so forth. In fact, this is a consequence of one standard axiomatization of additive measurement, specifically of the Archimedean condition (Kranz et al., 1971; Lassiter, 2011). We then predict that the corresponding adjectives (e.g. *heavy, long, wide, deep*, and their antonyms) will have relative standards, and this is precisely what we find. Thus the same underlying factor that yielded objectivity with respect to comparison constructions also yields a relative standard.

Interestingly, there are exceptions to the generalization that adjectives lexicalizing additive dimensions disallow zero measures, prime examples being *expensive/cheap*: something can have zero cost without ceasing to be the sort of thing whose cost we might inquire about. Another example might be *likely* (see again Lassiter 2011). Yet these nonetheless have relative standards. Here I would like to propose that additivity alone is sufficient to align their interpretation to that of other additive-dimension adjectives, yielding a relative standard; this might be thought of in terms of evolutionary pressures of the sort discussed by Qing and Franke (2014).

Let us turn now to adjectives whose (families of) measure functions have a different form, in particular those that can be stated as derived measure functions (classes (c) and (d) in Section 4). Whether an absolute or relative standard obtains is dependent on whether there is a scalar minimum and/or maximum point to which relevant individuals can be mapped. Here it is instructive to consider the lexical entries for *full* (15) and *dirty* (17), which are based on division. From their form, it is clear that an individual can have zero degree of dirtiness or fullness without ceasing to exist as something whose dirtiness or fullness might be at issue; this is the case when the numerator is zero but the denominator is not. The mapping for *full* also has a maximum point (when contents=capacity), as presumably does that for *clean*, assuming its scale in each context c to be the reverse of that for *dirty*. In either case, an endpoint-based standard induces a potentially non-trivial partition on the domain, and is therefore to be preferred. Thus again, the form of the measure functions lexicalized by the adjective determines standard type. Many absolute gradable adjectives lexicalize measure functions of this form (e.g. *flat/bumpy, dry/wet, smooth/rough, safe/dangerous*); what other types might exist requires further investigation.

Note that the above-stated principle governing standard types is independent of the stable versus variable nature of the property in question (contra Toledo and Sassoon 2011). Temperature is a variable property, but as there is for practical purposes no maximum or minimum temperature an object may have, the corresponding adjectives (e.g. *warm, hot*) have relative standards. Conversely, *purity* is arguably an enduring property, yet a substance may at least in principle be completely pure, making an endpoint standard non trivial; we correctly predict *pure/impure* to be absolute.

This brief discussion has not exhausted all types of gradable adjectives (in particularly, nothing has been said about the standards for evaluative adjectives such as *beautiful*). But it should be sufficient to see that objectivity/subjectivity and standard type are connected in a meaningful way.

6. Conclusions

The experiment reported in this paper yielded the surprising finding that a wide range of gradable adjectives display at least some degree of subjectivity in the interpretation of their comparative forms. Such adjectives divided into two groups, those that also allow objective or factual readings for the comparative, and those that do not. Furthermore, the availability of objective versus subjective interpretations was found to correlate with the distinction between relative and absolute gradable adjectives. A theory was put forward in which both of these patterns derive from the formal properties of the measure functions lexicalized by different sorts of adjectives, with an important role played in both cases by functions that are additive with respect to concatenation.

The account outlined here leaves a number of important questions open. Most centrally, we might ask how distinct the three groups identified in the experiment truly are, and whether they might be further subdivided. Among dimensional adjectives such as *tall*, are subjective readings for the comparative absolutely ruled out (as suggested here), or might such readings be allowed in certain contexts (per Kennedy 2013)? Among the purely subjective group, might there be other sources of subjectivity than those discussed here? How exception-free are the generalizations made about standard type? The relation between ordering subjectivity – particularly among the 'mixed' group – and other characteristics of evaluative predicates such as embedding under *find* also merits further study. I leave these as topics for future research.

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A signaling account of contrastive focus[1]

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Abstract. This paper outlines a model of contrastive focus placement based on signaling games (Lewis 1969, Franke 2011). First, a simple model of sentence-level focus in question-answer situations is developed. Then, the model is extended to apply to sub-sentential phrases. Finally, an iterative procedure is developed for determining foci at each level of syntactic structure. This extends simple noise-based explanations of focus placement (Schmitz 2008, Bergen and Goodman 2014) to account for more difficult cases such as farmer sentences.

Keywords: contrastive focus, information structure, game theory.

1. Introduction

It seems reasonable, in a sense, that in intonation languages such as English and German, in which the placement of stress is relatively fluid, higher prosodic prominence should be given to elements within a sentence that are crucial for interpretation, as opposed to elements that are redundant or recoverable from the context. This intuition arises from the simple fact that prosodic prominence, though conceived of as an abstract phonological notion, correlates systematically with phonetic prominence, such that phonologically stressed words and phrases are more likely to survive the effects of *noise* (Shannon 1948) on information transmission. The pragmatic relevance of noise, the stochastically determined deletion of parts of a meaningful signal, has been noted in recent years (Schmitz 2008, Benz 2012, Bergen and Goodman 2014), and, when combined with some basic principles of economy, provides a clear explanation of why e.g. the focus structure in (1a) is preferred to those in (1b) and (1c).

(1)   Who is teaching phonetics this semester?
       a.   **[Bill]**$_F$ is teaching phonetics this semester
       b.   # **[Bill is teaching phonetics this semester]**$_F$
       c.   # Bill is **[teaching]**$_F$ phonetics this semester

The question under discussion (QUD) sets up a set of alternatives {'Bill is teaching phonetics this semester', 'Sue is teaching phonetics this semester', etc.}, and everything in the answers in (1) except for the subject is redundant against that set (Roberts 1996). Thus the subject is what Schmitz (2008) calls the 'i-critical' material, i.e., the only material critical to listener interpretation. This is clear from the fact that everything but the subject can be elided in the answer. In fact, the elided version is arguably more natural, given that it takes less effort to produce.

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[1]Any useful contributions of this paper were made possible in part by input from Robin Clark, Chris Ahern, numerous conference attendees, and anonymous reviewers.
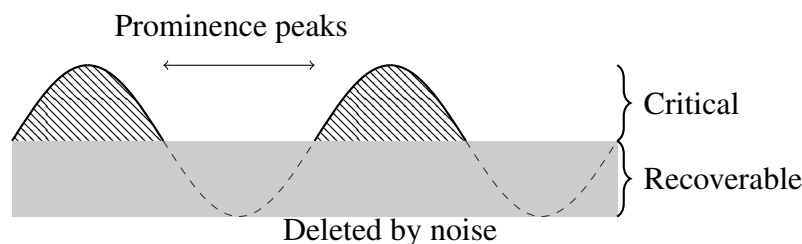
Figure 1: An ideal signal gives more prominence to what is critical, and less prominence to what the hearer could recover from context.

(2) Q: Who is teaching phonetics this semester?
     A: Bill.

This principle of least effort is encoded in theories of focus placement as a pressure to focus mark as little as possible (Rooth 1992, Schwarzschild 1999). The linking hypothesis behind this is that focus, being a marker of phonological prominence in languages like English, and thus correlating with phonetic prominence, tends to create greater effort in speech production. What must be focused, then, is that minimal 'i-critical' material whose denotation could not be recovered from context by the hearer in the event that noise prevents the successful transmission of that material. This is visualized in Fig.1: Ideally, the prominence peaks created by prosodic focus marking ensure the successful transmission of the critical material in the presence of noise, thereby ensuring the recoverability of the entire signal. We might expect conventions to develop in intonation languages which approximate this ideal, and thus a noise-based model of focus placement can serve to supplement formal descriptions (e.g., Rooth 1992, Wagner 2012) by explaining *why* such a system should exist in a variety of languages, and not, for example, an inverted system which marks critical information by de-accenting it.

It is not immediately obvious how this noise-based picture of focus placement extends to cases where elision is not possible, namely contrastive focus of the type seen in farmer sentences.

(3)   An **[American]**F farmer punched a **[Canadian]**F farmer. . .

Here, it is not the case that there is a QUD of the form {'a P farmer punched a Q farmer'}, and therefore nothing is recoverable from the global discourse context. However, we claim that noise can still play a role in this example, in that the twofold presence of *farmer* reduces the communicative need to elevate either instance of that word to prominence, given that, under certain pragmatic assumptions, if one instance survives the noise, the other will be recoverable.

This paper provides a noise-based account of contrastive focus extending to these cases. Focus placement is modeled as a signaling game between speaker and hearer, where the goal of the

game is for the speaker to choose the minimal critical information to send to the hearer, who must recover the speaker's intended meaning from this signal. By hypothesis, this minimal critical information is what determines focus placement. We begin by outlining the information-structural assumptions underlying the analysis (1.1) and giving an informal summary of the approach (1.2), before providing some background on signaling games (2), introducing the game-theoretic model (3) and deriving key examples (4).

1.1. Assumptions

For current purposes we assume a distinction between the marking of contrastive focus and the marking of givenness, where only the former requires a contrast roughly in the sense of Wagner (2012), which is illustrated in (4).

(4)   Mary's uncle, who buys and sells high-end convertibles for a living, is coming to Mary's wedding. I wonder what he got her as a present. . .
   a.   He got her a **[cheap]**$_F$ convertible
   b.   ? He got her a **[cheap convertible]**$_F$
   c.   # He got her a **[red]**$_F$ convertible
   d.   He got her a **[red convertible]**$_F$

There is a genuine semantic contrast between the contextually salient 'high-end convertibles' and 'cheap convertible', insofar as they are mutually exclusive descriptions, whereas no such contrast exists between 'high-end convertibles' and 'red convertible' (a car can be both high-end and red). Only when there is some contrast along these lines can the adjective be focused.[2]

In contrast to (4c), where accent cannot shift away from the modified noun *convertible* unless it is shifting onto a contrastive element, we find that non-modified XPs (i.e., maximal projections) can easily be 'de-accented' in the sense of Ladd (1996) merely in virtue of their being contextually salient (Stevens 2014). This shifts stress leftward onto an element that does not need to contrast with anything in the discourse context.

(5)   A: Mary just arrived in her new convertible. What do you think she wants to do tonight?
        B: She wants to paint PICTURES of convertibles

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[2]Contextual assumptions play a role, as noted by Katzir (2013). The adjectives 'red' and 'high-end' can create a contrast, e.g., in a context where car collectors are assumed to collect cars with one primary desired attribute, as in (i).

(i)   Alice collects **[high-end]**$_F$ convertibles, and Bob collects **[red]**$_F$ convertibles.

We follow Beaver and Clark (2008) and Stevens (2014) in positing that XPs in discourse whose meanings are highly salient—or *given* (Schwarzschild 1999)—can become 'inactive' for purposes of stress assignment, independently of focus placement. This would give B's utterance in (5) a structure like in (6), where the PP is 'inactive' due its being marked as given ('G-marked'), forcing the main stress within the focused VP to fall on *pictures*.

(6)   She wants to **[paint pictures [PP of convertibles]G]F**

In any case, we are only concerned here with cases where a meaningful contrast is present. This can either take the form of a semantic partition, e.g., over convertibles as in (4), or a pragmatic one, e.g., a well-defined QUD like in (1). The goal of the current analysis will be to define the placement of these foci in terms of strategies in a game of information transmission.

1.2. Informal summary of the proposal

Imagine a game of communication between two players, a *sender* (S) and a *receiver* (R). The rules are simple: S must select one object from an array of options visible to both players, and the goal is to get R to guess which object S has chosen. If this happens, both players win a cash prize. S can send R a written message indicating which object R should select, but only the first word is free. For each subsequent word contained in S's message, the prize money is reduced.

Now, imagine a specific instance of this game where the players are given the context in (4), which sets up the expectation that Mary's uncle bought her an expensive convertible for her wedding. Both players are presented with an array of object descriptions ('cheap convertible', 'cheap sedan', 'expensive convertible', 'expensive sedan'), one of which describes Mary's uncle's actual gift. S is told the identity of the gift, and is instructed to convey this to R. Informal experiments accord with our intuitions that, if S writes the message "cheap" to send to R, that S most likely intends to convey that R should guess that the cheap convertible was the gift, not the cheap sedan.

The proposed signaling analysis is based on the independently motivated principle that in coordination games—games in which two or more players try to select the same option from an array of options (Schelling 1960)—the players' options are labeled with values of salient *attributes* which create *partitions* over a semantic space, such that "when attributes come to mind they come in clusters... it is nearly impossible to notice that 'U' is a vowel without noticing that other objects are consonants." (Bacharach and Bernasconi 1997). The attribute clusters which come to mind are assumed to be conditioned by context, such that (4) evokes, or 'activates', the relevant attributes CATEGORY (convertibles vs. other types of gifts) and PRICE LEVEL (being expensive vs. cheap). Thus, when one is asked in the context of (4) to select a likely gift, one represents the possibility of Mary's uncle having bought her a convertible as a choice between different values of the attribute PRICE LEVEL, as represented in the AVM below.

(7) $\underset{\textit{description}}{\left[\begin{array}{ll}\textsc{category} & \lambda x.\ x \text{ is a convertible} \\ \textsc{price level} & \lambda x.\ x \text{ is expensive}\end{array}\right]}$ $\underset{\textit{description}}{\left[\begin{array}{ll}\textsc{category} & \lambda x.\ x \text{ is a convertible} \\ \textsc{price level} & \lambda x.\ x \text{ is cheap}\end{array}\right]}$

If the context creates an expectation or supposition or default belief that the gift is a convertible, then a message like "cheap" which omits the category information will be taken to specify 'cheap convertible' in opposition to 'expensive convertible', because if the category were different, that important information would have been included in the message. Crucially, this reasoning breaks down if the message makes reference to attributes which are not active in the context. In the context of (4), the game is conceived of as a choice between AVM structures representing CATEGORY and PRICE LEVEL, such that the message "red", which refers to the unrepresented attribute COLOR, is interpreted as a non-sequitur, casting doubt on the rationality of the sender. By hypothesis, it is for this reason that contrastive focus cannot be licensed in (4c).

Representing entity descriptions involves partitioning the space of predicates into meaningful attributes like category, color, price, etc., where each attribute is represented as a set of non-overlapping groups (for example, a car cannot be both expensive and cheap, assuming a fixed comparison class). Analogously, we can represent assertions as a pair of pragmatically motivated partitions: QUDs and answers. There is a similar mutual exclusivity, in that only one question can be the question under discussion currently being addressed, and only one answer is intended. This follows the structured meaning approach to QUDs (Krifka 2001, 2007) in partitioning the type-appropriate semantic space into possible arguments of the QUD, represented below as the value of the attribute ANSWER.

(8) $\underset{\textit{assertion}}{\left[\begin{array}{ll}\textsc{qud} & \lambda P.\ \text{Mary's uncle bought her a gift } x \text{ such that } P \text{ is true of } x \\ \textsc{answer} & \lambda x.\ x \text{ is expensive \& } x \text{ is a convertible}\end{array}\right]}$

Such structures allow us to sufficiently constrain the space of possible interpretations in order to construct a well-defined game-theoretic model, and in doing so, correctly predict the restrictions on contrastive focus placement noticed by Wagner (2012) and others. The mechanics of our game of communication are now rather simple. The sender has incentive to select messages that fully specify which option the receiver should choose. But the sender has an opposing incentive to make her message as short as possible. In a simple case like (1), given the two options below, it is obvious that "Bill" will suffice to coordinate on the first assertion.

(9) $\underset{\textit{assertion}}{\left[\begin{array}{ll}\textsc{qud} & \lambda x.\ x \text{ is teaching phonetics} \\ \textsc{answer} & \text{Bill}\end{array}\right]}$ $\underset{\textit{assertion}}{\left[\begin{array}{ll}\textsc{qud} & \lambda x.\ x \text{ is teaching phonetics} \\ \textsc{answer} & \text{Sue}\end{array}\right]}$

The case of (4) is more complex, because, given the message "cheap", the intended meaning could in principle be 'cheap sedan'. However, signaling games allow for probabilistic reasoning. Given a principled way of determining the receiver's *prior beliefs* about what the sender wants her to

What did he buy her?

He bought her a cheap convertible   . . . an expensive convertible   . . .

He bought her   **a cheap convertible**

a   **cheap convertible**

cheap   convertible
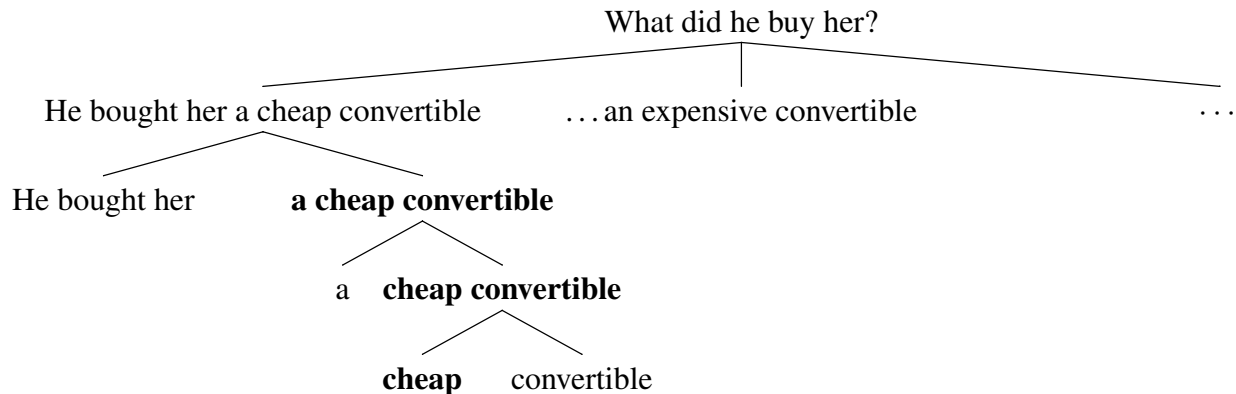
Figure 2: Information structure and partial syntactic structure of an utterance, with critical information marked in bold

choose, the game-theoretic model predicts that the receiver will employ pragmatic reasoning along the following lines.

1. I have received the message "cheap", therefore I assume the value of PRICE LEVEL is $[\![\text{cheap}]\!]$ = $\lambda x.\ x$ is cheap.

2. I assume by default that the most probable value for CATEGORY is $\lambda x.\ x$ is a convertible.

3. I know that the sender knows that I have this belief.

4. Therefore, if the sender had intended anything other than $\lambda x.\ x$ is a convertible, she would have specified the value of CATEGORY.

5. Therefore, the speaker must intend to convey that the gift is a cheap convertible.

The link between this idealized game and the actual facts of intonation is that a formalized version of this game supplies a model of how to calculate, at any level of linguistic structure, what the 'i-critical' information is, and that this critical information is marked as such, which feeds focus assignment in a particular way. To illustrate how this works, consider (4) once more. When we think of a version of our game where the choices before the players are assertions, represented with QUD and ANSWER attributes, the game predicts that only the ANSWER ('a cheap convertible') is critical for successful interpretation. When we zoom in to the content of the NP in the answer ('cheap convertible'), represented with CATEGORY and PRICE LEVEL attributes, taking into account the salience of 'high-end convertible' in the prior context, the critical information is the PRICE LEVEL. If we mark off the critical information at every level of structure, we can obtain a tree structure like in Fig.2. The link between this structure and accent placement is clear: The leaf node of the 'i-critical' sub-tree must be given focus. Moreover, we may tentatively posit that only nodes which are not dominated by any i-critical node can be elided. This predicts (10) below, while at the same time allowing for a principled analysis of farmer sentences, where no elision is possible.

(10)   Mary's uncle, who buys and sells expensive convertibles, is coming to her wedding.

Q: What did he buy her as a gift?

A: A **[cheap]**$_F$ convertible

Farmer sentences will be handled by assuming that when the signaling game is played at lower levels of structure (e.g., selecting from among possible NP meanings within the larger sentence) the surrounding utterance (e.g., everything outside the NP in the utterance) can be used as context to determine salience and prior probability. The intuition behind this is that, for example, the presence of 'American farmer' elsewhere in the sentence will prime NP meanings with NATIONALITY and PROFESSION attributes, with the antecedent itself making the 'American' and 'farmer' the default values. This in turn cashes out the intuition that doubly representing 'farmer' makes it a safer bet not to accent either instance, because if one gets through, the hearer can guess the identity of the other, assuming that if the value were different from the salient default, the corresponding word would have been focused.

With these intuitions in mind, we now introduce the formal game-theoretic analysis, beginning with some background on signaling games.

2. Signaling games

Signaling games are games of coordination (Schelling 1960) with two players, a *sender* (S) and a *receiver* (R), where the goal is for R to correctly determine a piece of information which is private to S, known as S's *type*. For purposes of pragmatic modeling, the type is typically taken to be a meaning that is to be conveyed to R. Because R cannot get inside S's head, this meaning cannot be observed directly, but rather must be inferred based on a *message* that S sends to R. The meaning that R interprets from S's message is known as the *action*, where actions and types are drawn from a single set of meaningful symbols. As a notational shorthand, a sender type who wants to convey meaning ϕ can be written t_ϕ, and similarly, an action where R selects meaning ϕ can be written a_ϕ. The *utility*—the quantity that is to be maximized by each player— is greater than zero for a type t_i sender and a receiver who takes action a_j if and only if $i = j$.

Formally, the game is a tuple $\langle \{S, R\}, \Phi, M, [\![\cdot]\!], T, \delta, A, U_S, U_R, \mathcal{C} \rangle$, where S and R are the sender and receiver, respectively, Φ is a set of semantic formulae, M is a *language* consisting of a set of possible messages (here, utterances of natural language), $[\![\cdot]\!]$ is a denotation function from M to Φ, T is the set of possible sender types, δ is a prior probability distribution over types in T, A is the set of possible receiver actions (for our purposes identical to T), U_S is the sender's utility function, a function from $T \times M \times A$ to $\mathbb{R}$, U_R is the receiver's utility function, a function from $T \times A$ to $\mathbb{R}$, and finally, $\mathcal{C}$ is a *cost* function, a function from $T \times M$ to $\mathbb{R}$, which is used to subtract a small amount of sender utility for lengthier, more effortful messages.

We assume that $T = A$, both a subset of $\Phi \cup \{\#\}$, where '$\#$' indicates a special type/action known as the *babbling* type/action. The goal of a type $t_{\#}$ sender is to "babble", i.e., to utter messages without conveying any meaning. We assume that the prior probability $\delta(t_{\#})$ of a babbling sender is very close to zero. We further assume that, while a babbler will in principle send any message without regard for semantics or message length, a babbling sender nonetheless tries to signal her type. The inclusion of this low-probability babbling sender allows us to derive proper equilibria which straightforwardly specify optimal responses to otherwise off-equilibrium messages. More specifically, this allows us to include an action $a_{\#}$ which corresponds to a judgment of infelicity, so that the receiver has a consistent response to messages that seem suboptimal.

$$U_R(t, a) = 1 \text{ iff } a = t$$
$$= 0 \text{ otherwise} \qquad \text{(i)}$$

$$U_S(t, m, a) = U_R(t, a) - \mathcal{C}(t, m) \qquad \text{(ii)}$$

The players are tasked with developing utility-maximizing *strategies* which specify how to behave in any possible state of the game. But utility depends on variables which are privately known only by the other player (for S, the action that R will take, and for R, S's type). To find optimal strategies for S and R in this game, we need to find a *perfect Bayesian equilibrium* (Harsanyi 1968, Fudenberg and Tirole 1991) which maximizes each player's *expected utility*, which is the probabilistically weighted average utility for all possible values of any unknown variables. An equilibrium for our purposes is a pair of strategies $\langle \mathcal{S}^*, \mathcal{R}^* \rangle$ such that each strategy maximizes its player's expected utility function given the other, where expected utility is formulated as follows.

$$EU_S(m|t, \mathcal{R}) = \sum_{a \in A} P(a|m, \mathcal{R}) \cdot U_S(t, m, a) \qquad \text{(iii)}$$

$$EU_R(a|m, \mathcal{S}) = \sum_{t \in T} P(t|m, \mathcal{S}) \cdot U_R(t, a) \qquad \text{(iv)}$$

As per the standard conception of perfect Bayesian equilibrium, $\mathcal{S}^*$ yields $\arg\max_m EU_S(m|t, \mathcal{R}^*)$ for each $t \in T$, and $\mathcal{R}^*$ yields $\arg\max_a EU_R(a|m, \mathcal{S}^*)$ for each $m \in M$, where crucially, the conditional probabilities $P(a|m, \mathcal{R}^*)$ and $P(t|m, \mathcal{S}^*)$ are rational and consistent beliefs about the private knowledge variables of the game.

One principled way of deriving an equilibrium in such games, given a reasonable set of default beliefs, is the *iterated best response* (IBR) procedure of Franke (2009, 2011), which is based on hierarchical reasoning models of rationality (Camerer et al. 2004, Bardsley et al. 2010) whereby optimal strategies are derived via hierarchical assumptions of the form, 'player 1 believes that player 2 believes that player 1 believes....' The standard form of IBR begins with a receiver R_0

	a_F	a_C	$a_\#$	$m_\emptyset$	m_F	m_C
t_F	1,1	0,0	0,0	✓*	✓*	✗
t_C	0,0	1,1	0,0	✓*	✗	✓*
$t_\#$	0,0	0,0	1,1	✓	✓	✓

Figure 3: A signaling game representation

who plays a *naive* default strategy whereby R assumes that S's message is literally true, i.e., that the sender is of a type t_ϕ such that $\phi \to [\![m]\!]$. We will also consider the possibility of a 'null message' $m_\emptyset$ of length zero which is compatible with any type. Putting it together: Given a message m, if $[\![m]\!] \in \Phi$, R_0 assumes that S's type entails $[\![m]\!]$, but if $m = m_\emptyset$, R_0 makes no such assumption about S's type. Due its low probability, R_0 never assumes a babbling sender.

We then begin iteration by formulating a sender strategy S_1 which maximizes $EU_S(m|t, R_0)$. Costs for sending lengthier messages are assumed to be very small, such that message length only serves as a tie breaker between possible messages. Therefore, maximizing $EU_S(m|t, R_0)$ can be accomplished by first taking arg $\max_m P(t|m, R_0)$, and then, if that set contains more than one message, choosing the shortest. The probability of coordination $P(t|m, R_n)$ is specified as follows.

$$P(t|m, R_n) = \frac{1}{|R_n(m)|} \text{ if } R_n(m) \text{ contains } t \tag{v}$$
$$= 0 \text{ otherwise}$$

Then, given a message m, receiver strategy R_2 takes the set of types that could have produced m, $\{t \in T \mid m \in S_1(t)\}$, and outputs the set of actions equal to the types from that set which maximize the prior δ. We can then keep iterating, constructing S_3 by analogy to S_1 and R_4 by analogy to R_2, etc., until convergence on a stable pair of strategies occurs. This stable fixed point is an equilibrium, and if the strategies entail distinct messages for each type, then it is a *separating equilibrium*. To illustrate with an extremely simple example, consider the following.

(11)   Q: Is Mary's uncle a farmer or a car salesman?
        A: He is a car salesman.

Let's model this as a signaling game where the two possible non-empty messages are *He is a farmer* and *He is a car salesman* (m_F and m_C, respectively), and the two possible types/actions are the denotations of those messages (t_F/a_F and t_C/a_C). Fig.3 gives the standard representation of this game. Base utilities (not considering the cost term) are given for each player for each type/action combination, and message columns are displayed in increasing order of cost. For each type/message combination, Fig.3 indicates whether that message is a priori *compatible* with that type, i.e., whether R_0 could ever guess that type given that message. Finally, the asterisks in the

message columns indicate types with a higher prior probability, i.e., a higher value of $\delta(t)$ (in this case, the non-babbling types). Applying IBR to this game, we converge by S_3 on an equilibrium. The equilibrium is written as a set of tuples of the form $\langle t, m, a \rangle$, where given t, S should send m, and given m, R should select a. Because each message is associated with a unique type, we have achieved a separating equilibrium. Quite simply, if the speaker sends a meaningful message, it should be taken at face value, and if the speaker sends an empty message, the receiver should judge this intentional silence to be infelicitous.

$$R_0 \Rightarrow \{m_F \to \{t_F\}, m_C \to \{t_C\}, m_\emptyset \to \{t_F, t_C\}\}$$
$$S_1 \Rightarrow \{t_F \to \{m_F\}, t_C \to \{m_C\}, t_\# \to \{m_F, m_C, m_\emptyset\}\}$$
$$R_2 \Rightarrow \{m_F \to \{t_F\}, m_C \to \{t_C\}, m_\emptyset \to \{t_\#\}\} \tag{vi}$$
$$S_3 \Rightarrow \{t_F \to \{m_F\}, t_C \to \{m_C\}, t_\# \to \{m_\emptyset\}\}$$
$$\text{Eq.} \Rightarrow \{\langle t_F, m_F, a_F \rangle, \langle t_C, m_C, a_C \rangle, \langle \, t_\#, m_\emptyset, a_\# \rangle\}$$

Having illustrated the basic mechanics of signaling games, we now extend this framework to account for the placement of contrastive foci.

3. Accounting for focus

We now expand on the traditional signaling approach in order to model the use of partial messages (e.g., "Bill") to convey larger meanings (e.g., 'Bill is teaching phonetics'). The intuitions outlined in 1.2 about representing meanings as attribute-value structures are cashed out formally by introducing three important notions: *component meaninghood*, *partitioning*, and *contextual availability*, each addressed in turn.

The AVMs in 1.2 have the property that the different attribute values compose together semantically, via function application or predicate modification, to produce the standard semantic denotation of the element in question. For example, the QUD $\lambda x.teach(x, phonetics)$ composes with $bill$ to yield the denotation of "Bill is teaching phonetics." The QUD and what it composes with are both *component meanings* of the entire assertion. A transitive and reflexive component meaninghood relation $\to_{comp}$ is defined formally as follows.[3]

$$A \to_{comp} B \text{ in } M \text{ iff either: (i) } \exists \rho \in M : [A(\llbracket \rho \rrbracket) = B] \vee [\llbracket \rho \rrbracket (A) = B], \text{ or}$$
$$\text{(ii) } \exists C.A \to_{comp} C \; \& \; C \to_{comp} B, \text{ or} \tag{vii}$$
$$\text{(iii) } A = B$$

Whereas the standard signaling model outlined in section 2 builds a default hearer strategy R_0 around the assumption that the denotation of S's message is entailed by S's type, our model builds R_0 around the assumption that the denotation of S's message (e.g., $bill$) is a component meaning

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[3] $\to_{comp}$ is defined relative to a language M in order to exclude vacuous formulae which are not found in natural language, e.g., $\lambda x.teach(bill, phonetics)$.

of S's type (e.g., $teach(bill, phonetics)$). Where this provides a constraint on the IBR mechanism, a *partition requirement* is needed to constrain the structure of the game itself, namely the space of possible types and actions. Formally, where Φ_u is the set of uncurried set representations of the semantic formulae in Φ, the constraint is formulated as follows.

$$\forall\langle\phi, \phi'\rangle \in \Phi_u \times \Phi_u : \ \phi \neq \phi' \rightarrow \phi \cap \phi' = \{\} \tag{viii}$$

Informally, the partition requirement ensures that the space of types and actions are drawn from a set of meanings Φ such that the members of Φ are mutually exclusive semantic descriptions. For example, a valid type space may include American farmers and Canadian car salesmen, but not American farmers and male farmers, since American farmers and male farmers are overlapping sets. This is a formalization of Bacharach's notion of attribute clusters.[4] Finally, as noted in 1.2, attribute clusters must be commonly believed to have 'come to mind' for both players. In other words, sets of alternative meanings, i.e., values of Φ must be *contextually available* in the following sense, borrowing from Schwarzschild (1999) notions of salient common ground (CG_S) and entailment under existential closure (ExClo):

(12)   A set of alternatives Φ is contextually available iff:
   a.   there is a salient proposition in the shared discourse context that entails that one of the members of Φ has a true existential closure (informal)
   b. $CG_S \Rightarrow [\exists\phi \in \Phi. \text{ExClo}(\phi)]$ (formal)

This requirement is always met by QUDs because the QUD itself is salient, and the QUD is assumed to have a true answer. This requirement is met by specific attribute clusters if and only if at least one member of the cluster is salient. For example, if $\exists x. American(x)$ is a salient fact in the discourse, then an attribute cluster like NATIONALITY containing $\lambda x. American(x)$ is available.

These requirements, taken together, allow us to model the placement of contrastive foci as a game where potentially underspecified messages are sent in order to most efficiently guide the receiver toward the correct intended meaning, given that meanings are drawn from a contextually available semantically or pragmatically motivated partition of a meaning space.

Putting it all together, we propose the following IBR procedure for determining the 'critical' information for a given type in a signaling game.

---

[4]For assertions that are structured into QUD and ANSWER attributes, some pragmatic enrichment of ϕ and ϕ' in the formulation of the partition requirement may sometimes be necessary, e.g., an exhaustivity operator to ensure that 'Bill is teaching phonetics' and 'Bill and Sue are both teaching phonetics' form a partition in cases where the speaker is assumed to be giving a maximally informative answer.

1. R_0:
   For all m in M, output the most probable type(s) "compatible" with m:

   - Partially order T from highest to lowest probability according to δ.

   - Output $T^*(m)$, where $T^*(m)$ is the set containing the highest-ranked type(s) t such that $[\![m]\!] \rightarrow_{comp} t$.

2. S_1:
   For all t in T, output the best message(s) to send to R_0:

   - Calculate $M^*(t) \subseteq M$ such that for all m in $M^*(t)$, $P(t|m, R_0) \geq P(t|m', R_0)$ for all $m' \in M$.

   - Partially order $M^*(t)$ by effort (from fewest to greatest number of syllables).

   - Output the set containing the lowest-effort message(s) in $M^*(t)$.

3. R_2:
   For all m in M, output the type(s) that are most likely to send m to S_1:

   - Output the set containing the most probable type(s) t such that $m \in S_1(t)$.

4. For $n \in \{4, 6, 8, \cdots\}$, calculate S_{n-1} and R_n by analogy to S_{n-3} and R_{n-2}, respectively, until convergence occurs.

5. Convergence occurs at a level S_n when for any given type/message pair $\langle t, m \rangle \in T \times M$, $t \in R_{n-1}(m) \leftrightarrow m \in S_n(t)$.

6. If each tuple $\langle t, m, a \rangle$, where $a \in R_{n-1}(m)$ and $m \in S_n(t)$, maps a single type to a distinct (set of) value(s) for m, then the set containing those tuples is a separating equilibrium.

The following section shows how this procedure is applied to concrete examples to derive contrastive foci at different levels of structure.

4. Deriving examples

4.1. Sentence-level focus

We start with a simple example of a question under discussion with only two possible answers.

(13)   There are two professors, Bill and Sue, one of which teaches phonetics each semester.
    Q: Who is teaching phonetics?
    A: Bill is teaching phonetics.

	a_{BP}	a_{SP}	$a_\#$	$m_\emptyset$	m_B	m_S	m_P	m_{BP}	m_{SP}
t_{BP}	1,1	0,0	0,0	✓*	✓*	✗	✓*	✓*	✗
t_{SP}	0,0	1,1	0,0	✓*	✗	✓*	✓*	✗	✓*
$t_\#$	0,0	0,0	1,1	✓	✓	✓	✓	✓	✓

Figure 4: Question-answer focus

The QUD in this case is $\{teach(bill, phonetics), teach(sue, phonetics)\}$. Let this be Φ, such that QUD $\cup \{\#\} = T = A$. To pick out the critical information within the sentence "Bill is teaching phonetics" in (13), we derive a separating equilibrium for the corresponding signaling game represented in Fig.4.

Let t_{BP} be a sender who wants to convey 'Bill is teaching phonetics', and t_{SP} a sender who wants to convey 'Sue is teaching phonetics.' R can select either of those two propositions as interpretations of S's message (a_{BP} and a_{SP}, respectively). We consider the following non-null messages.

m_B	"Bill"
m_S	"Sue"
m_P	"is teaching phonetics"
m_{BP}	"Bill is teaching phonetics"
m_{SP}	"Sue is teaching phonetics"

Messages m_B and m_{BP} have denotations which are component meanings of t_{BP}. Messages m_S and m_{SP} have denotations which are component meanings of t_{SP}. Message m_P has a denotation which is a component meaning of both t_{BP} and t_{SP}.

Applying our variant of IBR to this game, we converge on a separating equilibrium at S_3: For type t_{BP} the message "Bill" is best, and for type t_{SP} the message "Sue" is best. The Receiver will assume any other message to have been produced by a babbler, and thus the corresponding focus structures are judged to be infelicitous.

$$
\begin{aligned}
R_0 &\Rightarrow \{m_\emptyset, m_P \to \{t_{BP}, t_{SP}\}, m_B, m_{BP} \to \{t_{BP}\}, m_S, m_{SP} \to \{t_{SP}\}\} \\
S_1 &\Rightarrow \{t_{BP} \to \{m_B\}, t_{SP} \to \{m_S\}, t_\# \to M\} \\
R_2 &\Rightarrow \{m_B \to \{t_{BP}\}, m_S \to \{t_{SP}\}, m_\emptyset, m_P, m_{BP}, m_{SP} \to \{t_\#\}\} \\
S_3 &\Rightarrow \{t_{BP} \to \{m_B\}, t_{SP} \to \{m_S\}, t_\# \to \{m_\emptyset, m_P, m_{BP}, m_{SP}\}\} \\
\text{Eq.} &\Rightarrow \{\langle t_{BP}, m_B, a_{BP}\rangle, \langle t_{SP}, m_S, a_{SP}\rangle, \langle t_\#, \{m_\emptyset, m_P, m_{BP}, m_{SP}\}, a_\#\rangle\}
\end{aligned}
\tag{ix}
$$

Therefore, when the answer to the QUD is that Bill is teaching phonetics, the focus structure and intonation pattern should be as follows, with contrastive focus only on the portion of the utterance

which is most important for interpretation, i.e., that which corresponds to the "winning" message in our signaling game.

(14)   a.   **[Bill]**$_\textbf{F}$ is teaching phonetics
       b.   BILL is teaching phonetics.

The infelicitous patterns are ruled out on the grounds that they cannot be produced by a rational type t_{BP} Sender. This simple example illustrates how our enrichments to the signaling game come together to model the selection of critical information to be focused. The more interesting case is that of farmer sentences, to which we now turn.

4.2. Farmer sentences

Consider again (3), given again below as (15).

(15)   An **[American]**$_\textbf{F}$ farmer punched a **[Canadian]**$_\textbf{F}$ farmer. . .

To illustrate how the same game mechanics can derive this example, which is clear under formal accounts like Rooth (1992), but which is *prima facie* problematic for noise-based pragmatic explanations, we start by "zooming in" on the NP *American farmer*. The key claim we make here is that contrastive focus placement within this NP is calculated by treating the NP-external material as context for determining δ. That is, $\delta(t)$ for a given type is proportional to the *salience* of that type, such that the meanings that are salient in the utterance-internal context, *A(n) _____ punched a Canadian farmer*, give a large boost to $\delta(t)$ for types containing that meaning.[5] To illustrate, let's set up a game to model selection of focus at this NP node, considering for simplicity only four meaningful types: t_{aF} for 'American farmer', t_{aW} for 'American watchmaker', t_{cF} for 'Canadian farmer' and t_{cW} for 'Canadian watchmaker'. The game is represented in Fig.5. Crucially, we propose that salience within the NP-external, utterance-internal context determines the prior probability function, such that the following holds.

$$\delta(t_{aW}) < \delta(t_{aF}), \delta(t_{cW}) < \delta(t_{cF}) \tag{x}$$

We consider the following non-null messages.

---

[5]It is also possible to consider only context which precedes the target node in the linear order of the sentence. The possibility of both conceptions can account for why the contrastive focus on *American*, but not the contrastive focus on *Canadian*, is optional.

	a_{aF}	a_{aW}	a_{cF}	a_{cW}	$a_\#$	$m_\emptyset$	m_a	m_c	m_F	m_W	m_{aF}	m_{aW}	m_{cF}	m_{cW}
t_{aF}	1,1	0,0	0,0	0,0	0,0	✓	✓*	✗	✓	✗	✓*	✗	✗	✗
t_{aW}	0,0	1,1	0,0	0,0	0,0	✓	✓	✗	✗	✓	✗	✓*	✗	✗
t_{cF}	0,0	0,0	1,1	0,0	0,0	✓*	✗	✓*	✓*	✗	✗	✗	✓*	✗
t_{cW}	0,0	0,0	0,0	1,1	0,0	✓	✗	✓	✗	✓*	✗	✗	✗	✓*
$t_\#$	0,0	0,0	0,0	0,0	1,1	✓	✓	✓	✓	✓	✓	✓	✓	✓

Figure 5: Focus within an NP

m_a	"American"	m_{aF}	"American farmer"
m_c	"Canadian"	m_{aW}	"American watchmaker"
m_F	"farmer"	m_{cF}	"Canadian farmer"
m_W	"watchmaker"	m_{cW}	"Canadian watchmaker"

For any given message, the maximally probable compatible type is indicated with an asterisk. For example, the message "farmer" is compatible with types 'American farmer' and 'Canadian farmer', as well as the babbling type, among which 'Canadian farmer' is maximally probable due to 'Canadian' being salient in the context.

Now applying our solution procedure to this game, we obtain a separating equilibrium which pairs "American" with 'American farmer', "American watchmaker" with 'American watchmaker', the null message with 'Canadian farmer', "watchmaker" with 'Canadian watchmaker', and assumes all other messages to have been generated by $t_\#$. Note that the null message in this case corresponds to a lack of contrastive foci within the NP. This does not mean that no prosodic prominence should be assigned at all (see e.g. Selkirk 2007).

$$
\begin{aligned}
R_0 \Rightarrow &\{m_a, m_{aF} \to \{t_{aF}\}, m_\emptyset, m_c, m_F, m_{cF} \to \{t_{cF}\}, \\
&m_W, m_{cW} \to \{t_{cW}\}, m_{aW} \to \{t_{aW}\}\} \\
S_1 \Rightarrow &\{t_{aF} \to \{m_a\}, t_{aW} \to \{m_{aW}\}, t_{cF} \to \{m_\emptyset\}, t_{cW} \to \{m_W\}, t_\# \to M\} \\
R_2 \Rightarrow &\{m_a \to \{t_{aF}\}, m_\emptyset \to \{t_{cF}\}, m_W \to \{t_{cW}\}, m_{aW} \to \{t_{aW}\}, \\
&m_{aF}, m_{cF}, m_{cW}, m_c, m_f \to \{t_\#\}\} \\
S_3 \Rightarrow &\{t_{aF} \to \{m_a\}, t_{aW} \to \{m_{aW}\}, t_{cF} \to \{m_\emptyset\}, t_{cW} \to \{m_W\}, \\
&t_\# \to \{m_{aF}, m_{cF}, m_{cW}, m_c, m_f\}\} \\
\text{Eq.} \Rightarrow &\{\langle t_{aF}, m_a, a_{aF}\rangle, \langle t_{aW}, m_{aW}, a_{aW}\rangle, \langle t_{cF}, m_\emptyset, a_{cF}\rangle, \langle t_{cW}, m_W, a_{cW}\rangle, \\
&\langle t_\#, \{m_{aF}, m_{cF}, m_{cW}, m_c, m_f\}, a_\#\rangle\}
\end{aligned}
\tag{xi}
$$

The final step is to formulate a principled procedure for repeating this game at every node and mapping the results to a contrastive focus structure for the whole sentence. We start by specifying a syntactic structure in Fig.6. We iterate the game through this tree as follows.
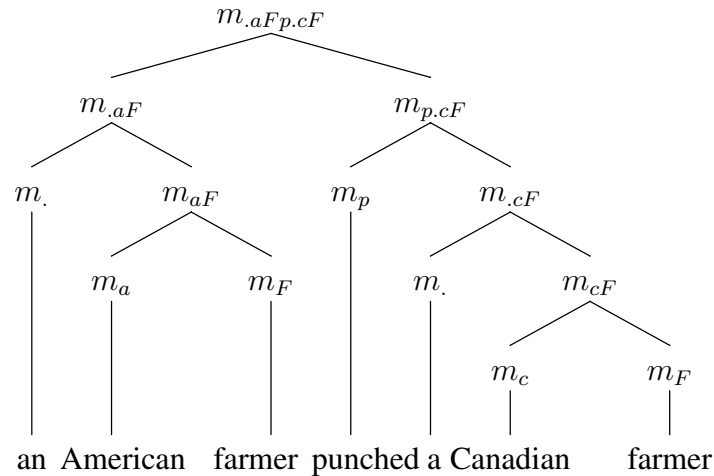
Figure 6: Syntactic structure of a farmer sentence

- Beginning at the root node N of a sentence-level focus as determined by the question under discussion, assuming N has two daughters, A and B:

  1. If there exists a contextually available set Φ_N of mutually exclusive possible meanings of the same semantic type, where Φ_N contains $[\![N]\!]$:

     (a) Let M_N be a set of messages such that for all m in M_N, $[\![m]\!]$ is either a member of Φ_N, or else a component meaning of a member of Φ_N which is of the same semantic type as either $[\![A]\!]$ or $[\![B]\!]$.

     (b) Consider a game where $A = T = \Phi_N \cup \{\#\}$ and $M = M_N \cup \{m_\emptyset\}$; if a separating equilibrium exists, let WINNER(N) be the optimal message for type $t_{[\![N]\!]}$.

     (c) If either $[\![A]\!]$ or $[\![B]\!]$ is a component meaning of $[\![\text{WINNER}(N)]\!]$, then mark the corresponding daughter node as a winning node.

     (d) If either A or B are marked as winning nodes, repeat step 1 at the winning node(s), if they are branching.

  2. If no such contextually available set exists, repeat step 1 at any branching daughter nodes.

- After all iterations, any winning node that does not immediately dominate another winning node is marked as a focus.

Only branching nodes and their immediate daughters are input to the game at a given node. The procedure begins by considering the QUD, as any nodes that are informationally redundant given the QUD do not need to be considered as targets for contrastive focus at lower levels. As in Fig.2 in 1.2, only leaf node winners determine focus. This avoids generating redundant nested foci.

Assume a simplified context for (3) where the possible nationalities are Canadian and American, and the possible professions are farmer and watchmaker, with two possible actions, punching and kicking. If we take the QUD to be something broad like 'what happened?', then prominence should be assigned over the whole utterance. To determine whether further any foci exist further down the tree, we then begin iteration at the root node $m_{.aFp.cF}$, checking whether there is a contextually available set of meanings $\Phi_{aFp.cF}$ which contains the sentence meaning. This would require an antecedent denotation of the form, 'a(n) American/Canadian farmer/watchmaker punched/kicked a(n) American/Canadian farmer/watchmaker.' Insofar as no such antecedent exists, no game can be played at this node, and we simply move on. No game can be played at node $m_{p.cF}$ either. Moving down to $m_{.cF}$, we can construct a valid set of types $T_{.cF} = \{t_{.aF}, t_{.cF}, t_{.aW}, t_{.cW}\}$ due to the salience of 'an American farmer' in the node-external context. The messages considered for this game are $m_{.cF}$ (= 'a Canadian farmer'), $m_{.}$, m_{cF}, m_{aF}, m_{cW} and m_{aW}. IBR yields the following separating equilibrium:

$$\text{Eq.} \Rightarrow \{\langle t_{.aF}, m_\emptyset, a_{.aF}\rangle, \langle t_{.aW}, m_{aW}, a_{.aW}\rangle, \langle t_{.cF}, m_{cF}, a_{.cF}\rangle, \langle t_{.cW}, m_{cW}, a_{.cW}\rangle,$$
$$\langle t_\#, \{m_{aF}, m_.\}, a_\#\rangle\} \tag{xii}$$

The winner at this node is "Canadian farmer". Continuing through the tree, we can derive separating equilibria for $m_{.aF}$ and m_{cF} by analogy to $m_{.cF}$ and m_{aF}, respectively, and then put it all together to obtain the following list of winning messages.

$$
\begin{array}{llll}
t_{.aF} & \Rightarrow \text{"American farmer"} \quad & t_{.cF} & \Rightarrow \text{"Canadian farmer"} \\
t_{aF} & \Rightarrow \text{"American"} & t_{cF} & \Rightarrow \text{"Canadian"}
\end{array}
\tag{xiii}
$$

Putting it all together, we generate the correct contrastive focus placements.

(16)   An **[American]**_F farmer punched a **[Canadian]**_F farmer

This analysis extends the signaling model of communication, a powerful and flexible formal tool, to account for the role of noise in contrastive focus placement within sentences and sub-sentential phrases. Much work remains to assess the ease with which this approach can be employed to account for the many interesting phenomena related to focus including association with focus, second occurrence focus and more.

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Nominal Ellipsis and the Interpretation of Gender in Greek[1]

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Abstract. Merchant (2014) observes that Greek has three classes of masculine-feminine noun pairs that differ in whether nominal ellipsis with gender mismatches is possible . We put forward an account of this observation, building on the idea that while certain gendered nouns have their gender inferences as part of their lexical semantics, others are underspecified and only obtain a gender inference via competition with the opposite gender. We claim that the behavior of the three classes of nouns under nominal ellipsis with gender mismatches falls out straightforwardly from their semantics under an auxiliary assumption that gender competition does not happen under nominal ellipsis.

Keywords: Gender, Nominal Ellipsis, Alternatives, Focus, Greek

1. Introduction

Merchant (2014) observes that human-denoting masculine-feminine noun pairs in Greek are classified into three groups according to whether nominal ellipsis with a gender mismatch is possible (see Bobaljik and Zocca 2011 for essentially the same observation in other languages, primarily Brazilian Portuguese): For Class I nouns like *adherfos* 'brother' vs. *adherfi* 'sister', nominal ellipsis with mismatching genders is not possible at all; By contrast, 'epicene nouns' (i.e. nouns that lack morphological gender marking) like *jatros* 'doctor' that constitute Class II allow for nominal ellipsis with gender mismatches with a masculine or feminine antecedent; Furthermore, for Class III nouns like *dhaskalos* vs. *dhaskala* 'teacher', nominal ellipsis with gender mismatches is grammatical when the antecedent is masculine but not when the antecedent is feminine. The following examples demonstrate these points. In these examples, the intended gender of the elided noun is visible on the determiner (D) and adjective (A).[2]

[2]The supposed elided phrases are indicated throughout the paper as ⟨~~ELLIPSIS~~⟩. Eventually, we will claim that what is elided is always totally identical to the antecedent, even in (3a), so according to our final analysis, what is elided in (3a) is actually the masculine noun *dhaskalos*, although the D and A are marked feminine. Also, it should be noted here that the data below are problematic for the analysis proposed by Merchant (2014), but for reasons of space, we will not discuss his analysis in the present paper, and refer the reader to Sudo and Spathas (2015).

(1) Class I

  a. * O Petros episkefthike enan **aderfo** tu sti   Veria, ke mia   ⟨a̶d̶e̶r̶f̶i̶⟩ stin
       the Petros visited   one.M brother his in.the Veria, and one.F (sister) in.the
       Katerini.
       Katerini

       (intended) 'Petros visited a bother of his in Veria, and a (sister) in Katerini.'

  b. * O Petros episkefthike mia **aderfi** tu sti   Veria, ke enan   ⟨a̶d̶e̶r̶f̶o̶⟩ stin
       the Petros visited   one.F sister his in.the Veria, and one.M (brother) in.the
       Katerini.
       Katerini

       (intended) 'Petros visited a sister of his in Veria, and a (brother) in Katerini.'

(2) Class II

  a. O Petros episkefthike enan **jatro** sti   Veria, ke mia   ⟨j̶a̶t̶r̶o̶⟩ stin
       the Petros visited   one.M doctor in.the Veria, and one.F (doctor) in.the
       Katerini.
       Katerini

       'Petros visited a male doctor in Veria, and a female doctor in Katerini.'

  b. O Petros episkefthike mia **jatro** sti   Veria, ke enan   ⟨j̶a̶t̶r̶o̶⟩ stin
       the Petros visited   one.F doctor in.the Veria, and one.M (doctor) in.the
       Katerini.
       Katerini

       'Petros visited a female doctor of his in Veria, and a male doctor in Katerini.'

(3) Class III

  a. O Petros episkefthike enan **dhaskalo** sti   Veria, ke mia   ⟨d̶h̶a̶s̶k̶a̶l̶a̶⟩ stin
       the Petros visited   one.M teacher.M in.the Veria, and one.F (teacher.F) in.the
       Katerini.
       Katerini

       'Petros visited a male teacher in Veria, and a female teacher in Katerini.'

  b. * O Petros episkefthike mia **dhaskala** sti   Veria, ke enan   ⟨d̶h̶a̶s̶k̶a̶l̶o̶⟩ stin
       the Petros visited   one.F teacher.F in.the Veria, and one.M (teacher.M) in.the
       Katerini.
       Katerini

       (intended) 'Petros visited a female teacher of his in Veria, and a male teacher in
       Katerini.'

Contrary to these gender mismatching cases, gender matching nominal ellipsis is possible with all
three classes of nouns (data omitted here; see Merchant 2014; Sudo and Spathas 2015). In the
discussion to follow, we will treat the above three pairs of nouns as representatives of the three

classes, and simply refer the reader to Merchant (2014: (19), (24), (27)) for more examples of gendered nouns in Greek.

It should be noted at this point that there seems to be no obvious morphological clue as to which class a given pair of gendered nouns belongs to, except that Class II nouns generally have only one form in Greek (but see Bobaljik and Zocca 2011 for other languages where Class II nouns also have two forms). Consequently, we have little to say about the role of morphology in the present phenomenon (see Bobaljik and Zocca 2011 for interesting ideas), and we also have to leave the acquisition of these nouns for future research.[3] Rather, our focus here is on explaining the above differences among the three classes of gendered nouns under nominal ellipsis with gender mismatches in terms of the syntax and semantics of these nouns.

The structure of the present paper is as follows. We will propose in Section 2 that the behavior of Class I and Class II nouns follow from their lexical semantics together with independently motivated assumptions about (nominal) ellipsis. In particular, we present evidence that certain genders are lexically specified, while others only arise via competition with the opposite gender. In Section 3, we claim that with an additional auxiliary assumption that gender competition does not happen under ellipsis, the behavior of Class III nouns also falls out naturally. We will conclude in Section 4 and discuss further issues.

2. The Denotations of Gendered Nouns

Let us start with the denotations of gendered nouns in Greek. We propose the following semantics: Class I nouns always lexically specify gender, while Class II nouns generally do not have lexically specified gender (as suggested by the lack of morphological marking). Furthermore, Class III nouns are asymmetric in that masculine nouns have no lexically specified gender, while feminine nouns have lexically specified gender. This is summarized in (4)–(6). Notice that when a noun lexically specifies gender, the gender inference is both presupposed and asserted.[4]

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[3]Relatedly, see Merchant's remarks in his fn.6 about the data collection and potential inter-speaker variation. In particular, speakers of Greek might differ in whether they assign a pair of masculine-feminine nouns to Class I or Class III, and there indeed seem to be speakers for whom the pair *dhaskalos-dhaskala* behaves like Class I nouns. Importantly, however, we have found no speaker that doesn't attest all three classes. Moreover, if a speaker classifies a pair in one of the classes, they treat it uniformly for all the tests provided throughout the paper.

[4]As for Class I nouns, there is an analytical possibility that the presupposition of the masculine form is gender neutral, but the infelicity of sentences like the following suggest that this is not the case. That is, these sentences are not simply false, and more adequately described as involving presupposition failure.

(1)   a. #I Maria ine adherfos tu   Jani.
             the Maria is brother the.GEN Janis.GEN

             'Maria is a brother of Janis's.'

     b. #I Maria ke o Petros ine adherfi tu   Jani.
             the Maria and the Petros are brothers the.GEN Janis.GEN

             'Maria and Petros are brothers of Janis's.'

(4)   Class I
   a. $[\![\text{adherfos}]\!] = \lambda x_e : \mathbf{male}(x). \ \mathbf{male}(x) \wedge \mathbf{sibling}(x)$
   b. $[\![\text{adherfi}]\!] = \lambda x_e : \mathbf{female}(x). \ \mathbf{female}(x) \wedge \mathbf{sibling}(x)$

(5)   Class II
   $[\![\text{jatros}]\!] = \lambda x_e. \ \mathbf{doctor}(x)$

(6)   Class III
   a. $[\![\text{dhaskalos}]\!] = \lambda x_e. \ \mathbf{teacher}(x)$
   b. $[\![\text{dhaskala}]\!] = \lambda x_e : \mathbf{female}(x). \ \mathbf{female}(x) \wedge \mathbf{teacher}(x)$

We assume that other exponents of gender features than nouns, such as D and A, merely presuppose the gender, and do not assert it and furthermore [masculine] is semantically empty, as in (7) and (8). For expository purposes, we assume here that indefinite articles denote existential determiners, and adjectives function as intersective modifiers, but nothing crucial hinges on this. We also ignore number features here.[5]

(7)   a. $[\![\text{enan}]\!] = \lambda P_{\langle e,t \rangle}.\lambda Q_{\langle e,t \rangle}.\exists x(P(x) \wedge Q(x))$
   b. $[\![\text{mia}]\!] = \lambda P_{\langle e,t \rangle}.\lambda Q_{\langle e,t \rangle} : \forall x(P(x) \rightarrow \mathbf{female}(x)). \ \exists x(P(x) \wedge Q(x))$

(8)   a. $[\![\text{kalos}]\!] = \lambda x_e. \ \mathbf{good}(x)$
   b. $[\![\text{kali}]\!] = \lambda x_e : \mathbf{female}(x). \ \mathbf{good}(x)$

In what follows, we will present two pieces of evidence for the lack of lexically specified gender for Class II nouns (e.g. *jatros* 'doctor') and Class III masculine nouns (e.g. *dhaskalos* 'teacher'), as in (4)–(6) above. Some of the examples in this section and next section also support the lack of asserted gender on D and A and the gender-neutrality of [masculine] on D and A, as in (7)–(8). After that, we will argue that this semantics explains the behavior of Class I and Class II nouns under nominal ellipsis with gender mismatches with independently motivated assumptions about ellipsis licensing.

Also, by keeping the masculine presupposition in Class I masculine nouns, we can maintain the uniformity of the interpretation of gender features on nouns: if a noun is lexically specified for (natural) gender, it both presupposes and asserts it, and if not, it is simply unmarked.

[5]The universal presupposition (7b) is arguably too strong. See Sudo (2012) and references therein for ways to weaken it. Also, we could adopthere the analysis of phi-features put forward by Sauerland (2003, 2008), which postulates a semantically interpretable occurrence of the gender feature outside of DP, which syntactically agrees with the uninterpretable occurrences appearing on D and A. As the theoretical choice here is inconsequential for our purposes in the present paper, we will omit the details.

2.1. Unmarkedness

In a number of languages, [masculine] is semantically unmarked relative to [feminine] in the sense that the masculine form is actually semantically gender-neutral (Heim, 2008; Percus, 2006; Sauerland, 2003, 2008; Spathas, 2010). In Greek, masculine pronouns, for example, can be used gender-neutrally in sentences like the following. Here, the intended reading is one where the pronoun *tu/tis* is bound by the disjunctive subject *some male student or some female student*.

(9)   a.   Kapios fititis   i kapia fititria   evapse to domatio tu.
           some.M student.M or some.F student.F painted the room   his
           'Some male student or some female student painted his room.'

     b.   * Kapios fititis   i kapia fititria   evapse to domatio tis.
           some.M student.M or some.F student.F painted the room   her
           'Some male student or some female student painted her room.'

The unacceptability of (9b) shows that feminine pronouns are exclusively used for feminine referents. We will see some more evidence of the gender-neutrality of [masculine] in Greek below, i.e. (11a), (12a), (14a) and (15a) (see also Spathas 2010).

That said, [masculine] often comes with a gender inference. To account for this, we adopt the idea that [masculine] is actually semantically empty in Greek, but sometimes comes with a gender inference as a result of competition with [feminine]. The details of this mechanism will be discussed in the next section.

Even in a language like Greek in which [masculine] is unmarked and semantically empty, one can find nouns that have lexically specified masculine gender. For such nouns, gender inferences are never semantically empty. We raise two sets of data showing that Class I masculine nouns have lexically specified gender, while Class II and Class III masculine nouns don't and have unmarked semantics just like masculine pronouns. They also show that feminine nouns in Greek all have lexically specified gender.

Firstly, when plural, Class II nouns with masculine D and/or A (e.g. *kali jatri* 'good.M doctors') and Class III masculine nouns (e.g. *dhaskali* 'teachers.M') can describe mix-gendered groups, while the rest cannot, as shown below.

(10) Class I
     a.   * O Petros ke i Maria ine aderfoi tu   Jani.
           the Petros and the Maria are brothers the.GEN Janis.GEN
           '*Petros and Maria are brothers of Janis's.'

      b.   * O Petros ke i   Maria ine adherfes tu   Jani.
           the Maria and the Petros are sisters   the.GEN Janis.GEN

           'Maria and Petros are sisters of Janis's.'

(11)   Class II

      a.   O Petros ke i   Maria ine kali   jatri.
           the Petros and the Maria are good.M doctors

           'Petros and Maria are good doctors.

      b.   * O Petros ke i   Maria ine kales   jatri.
           the Petros and the Maria are good.F doctors

(12)   Class III

      a.   O Petros ke i   Maria ine dhaskali   stin   Katerini.
           the Petros and the Maria are teachers.M in.the Katerini

           'Petros and Maria are teachers in Katerini.'

      b.   * O Petros ke i   Maria ine dhaskales stin   Katerini.
           the Petros and the Maria are teachers.F in.the Katerini

This suggests that Class I masculine nouns have gender inferences as lexical entailments, and also that feminine nouns in all three classes are always associated with a lexically specified gender inference, as we claim here. Notice also that (11a) and (12a) demonstrate that [masculine] on D and A is semantically gender neutral.

Another indication of the unmarkedness of Class II and Class III masculine nouns is their behavior in negative existential sentences. They do not restrict the domain of quantification to male individuals, unlike Class I masculine nouns or feminine nouns, which restrict the domain of quantification exclusively to female individuals. Thus, semantically unmarked nouns give rise to stronger entailments in the following examples.

(13)   Class I

      a. O Petros dhen exi kanenan adherfo.
         the Petros not   has no.M   brother

         'Petros has no brother.'   ⇏ Petros has no sister

      b. O Petros dhen exi kamina adherfi.
         the Petros not   has no.F   sister

         'Petros has no sister.'   ⇏ Petros has no brother

(14)   Class II

      a. O Petros dhen exi kanenan jatro.
         the Petros not   has no.M   doctor

         'Petros has no doctor.'   ⇒ Petros has no female doctor

    b. O Petros dhen exi kamia jatro.
         the Petros not   has no.F   doctor

         'Petros has no female doctor.' $\nRightarrow$ Petros has no male doctor

(15)   Class III

    a. O Petros dhen exi kanenan dhaskalo stin   Katerini.
       the Petros not   has no.M   teacher.M in.the Katerini

       'Petros has no teacher in Katerini.' $\Rightarrow$ Petros has no female teacher in Katerini

    b. O Petros dhen exi kamia dhaskala stin   Katerini.
       the Petros not   has no.F   teacher.F in.the Katerini

       'Petros has no female teacher in Katerini.' $\nRightarrow$ Petros has no male teacher in Katerini

These data point to the same conclusion: Class II nouns and Class III masculine nouns are gender neutral, while the rest are lexically specified for gender. In addition, (14a) and (15a) again demonstrate that [masculine] on D and A are gender neutral.

2.2. Focus Constructions

Secondly, certain focus constructions can be used to diagnose the presence of lexically specified gender. It is known that certain focus constructions are oblivious to presuppositions triggered by φ-features, including gender presuppositions (see Spathas 2010; Jacobson 2012; Sauerland 2013 for relevant discussion).[6] For instance, consider the following examples, under the bound readings of the possessive pronouns.

(16)   a. Of all the students, only I did my homework.

      b. Of all the students, only John did his homework.

      c. Of all the students, only Mary did her homework.

Suppose that the relevant students are the speaker, John and Mary. Then, (16a) entails that Mary and John didn't do their homework, (16b) that the speaker and Mary didn't do their homework, and (16c) that the speaker and John didn't do their homework. What is of importance here is that the φ-features (the person and gender features here) of the bound possessive pronoun seem to have

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[6]There is controversy in the literature regarding the analysis of examples like (16). In particular, one popular analysis says that the φ-features on these pronouns are semantically uninterpreted and are morphological reflections of the agreement relation with the binder (Heim, 2008; Kratzer, 1998, 2009), but there are other ideas as well (Spathas, 2010; Jacobson, 2012; Sauerland, 2013; Sudo, 2012, 2014). For the most part, we can be neutral with respect to this debate, but for certain data points, e.g. (25), the agreement-based theory has nothing to say, as there is nothing that agrees with the gender marking (see Spathas 2010 and Sudo 2012 for similar arguments against the agreement-based theory).

no semantic effects in the focus alternatives. For instance, what is negated in (16c) looks like the following, and the third person and feminine features do not figure here.

(17)   a.   I did my homework.
       b.   John did his homework.

Generally, φ-features, which are considered to be presupposition triggers (see the above references and also Cooper 1983; Heim 2008; Jacobson 2012; Sauerland 2003, 2008; Sudo 2012), have no semantic contribution in the focus alternatives. On the other hand, the asserted gender is not ignored in the alternatives, as shown below. Here, the entailments about individuals of the opposite gender are trivially true, because the asserted gender simply does not apply to them.

(18)   a.   Only John is a male athlete. $\nRightarrow$ Mary is not a female athlete.
       b.   Only Mary is a female athlete. $\nRightarrow$ John is not a male athlete.

Let us apply this test to gendered nouns in Greek. The following examples demonstrate that with Class II nouns and Class III masculine nouns, the gender restrictions do not apply to the alternatives, while with the rest, they do.

(19)   Class I
       a.   Mono o   Petros ine adherfos tu   Jani.
            only   the Petros is   brother the.GEN Janis.GEN
            'Only Petros is a brother of Janis'.' $\nRightarrow$ Maria is not Janis's sister.
       b.   Mono i   Maria ine adherfi tu   Jani.
            only   the Maria is   sister the.GEN Janis.GEN
            'Only Maria is a sister of Janis'.' $\nRightarrow$ Petros is not Janis's brother.

(20)   Class II
       a.   Mono o   Petros ine kalos   jatros.
            only   the Petros is   good.M doctor
            'Only Petros is a good doctor.' $\Rightarrow$ Maria is not a good doctor.
       b.   Mono i   Maria ine kali   jatros.
            only   the Maria is   good.F doctor
            'Only Maria is a good doctor.' $\Rightarrow$ Petros is not a good doctor.

(21)   Class III
       a.   Mono o   Petros ine dhaskalos.
            only   the Petros is   teacher.M
            'Only Petros is a teacher.' $\Rightarrow$ Maria is not a teacher.

b. Mono i   Maria ine dhaskala.
    only   the Maria is   teacher.F
    'Only Maria is a teacher.'   ⇏ Petros is not a teacher.

Notice that these data also suggest that the gender inferences on A are merely presuppositional. Other focus constructions point to the same conclusion, e.g. superlative constructions of the form *the best N* (the data are omitted here to save space; see Sudo and Spathas 2015).

2.3. Partial Resolution of the Puzzle

We take the above data to show that Class II nouns and Class III masculine nouns do not have lexically specified gender, while the rest do, as in (4)–(6). Based on this semantics, we claim here that part of the ellipsis data presented in Section 1, namely the behavior of Class I and Class II nouns, can be explained straightforwardly, once an independently motivated assumption about ellipsis is made. Specifically, presuppositions triggered by φ-features are known to be ignored for the purposes of ellipsis licensing (cf. Fiengo and May 1994). This is illustrated by the following example involving VP ellipsis in English.

(22)   Mary [$_{VP}$ hates her supervisor], but John doesn't [$_{VP}$ ⟨hates his supervisor⟩].

Here the pronouns in the two VPs have different φ-features, but VP ellipsis is licensed. On the other hand, the asserted genders matter, as illustrated by the following example.

(23)   *Mary is a female candidate, and John is ⟨a male candidate⟩ too.

On the assumption that the same generalization holds with nominal ellipsis in Greek, the behavior of Class I and Class II nouns in (1) and (2) follows naturally from the semantics of the nouns. Recall that according to our proposal, Class I nouns have lexically specified gender with asserted gender inferences, while Class II nouns are void of gender inferences, as in (4) and (5). Thus our predictions are the following: For Class I nouns, nominal ellipsis with gender mismatches is not possible, since the gender inference is asserted. This is correct, as in (1). By contrast, for Class II nouns, which do not have lexically specified gender, nominal ellipsis with gender mismatches is possible, regardless of the gender of the antecedent noun. This prediction is also borne out, as in (2).

On the other hand, the behavior of Class III nouns remains a puzzle. The examples in (3) demonstrate that with Class III nouns, nominal ellipsis with a gender mismatch is licensed when the antecedent is masculine, but not when it is feminine. Our semantics for Class III nouns actually

incorrectly predicts nominal ellipsis with gender mismatches to be impossible in either case. This is for the following reasons. Firstly, recall that according to our semantics in (6), the feminine noun has a stronger assertion than the masculine noun. Secondly, ellipsis is generally not licensed with an asymmetric entailment, as demonstrated by the following examples of nominal ellipsis in English.

(24) a. * John cited two phonologists. Mary cited four ⟨linguists⟩.
      b. * John cited two linguists. Mary cited four ⟨phonologists⟩.

Thus, the puzzle here is why nominal ellipsis with gender mismatches involving Class III nouns is possible at all to begin with. We offer a solution to this puzzle in the next section.

3. No Gender Competition under Ellipsis

3.1. Proposal

We assume that nominal ellipsis in Greek requires total identity between the antecedent noun and the elided noun. This implies that what is elided in (3a) is actually a masculine noun, even though the determiner is marked [feminine]. Thus, we analyze the data in (3) as follows.

(3′) a. O Petros episkefthike enan **dhaskalo** sti   Veria, ke mia ⟨dhaskalo⟩ stin
          the Petros visited   one.M teacher.M in.the Veria, and one.F (teacher.M) in.the
          Katerini.
          Katerini

          'Petros visited a male teacher in Veria, and a female teacher in Katerini.'
      b. * O Petros episkefthike mia **dhaskala** sti   Veria, ke enan ⟨dhaskala⟩ stin
          the Petros visited   one.F teacher.F in.the Veria, and one.M (teacher.F) in.the
          Katerini.
          Katerini

          (intended) 'Petros visited a female teacher of his in Veria, and a male teacher in Katerini.'

Notice importantly that (3′a) becomes ungrammatical without ellipsis. Thus, we need to assume that the DP-internal gender mismatch we postulate here is somehow only ruled in with ellipsis. This might seem outlandish at first, but there is evidence for the hidden masculine noun in (3′a). Recall that the Class III masculine noun *dhaskalos* has no lexically specified gender. Then, our analysis here makes a prediction that when an elided masculine noun with a feminine determiner occurs in a focus construction, the interpretation should not be restricted to female individuals. This prediction is borne out, as demonstrated by the following example.

(25)   a. I   perisoteri apo emas den ehun dhaskalo stin   Katerini.
            the more   from us   not have teacher.M in.the Katerini
            'Most of us don't have a teacher in Katerini.'

        b. Mono i   Maria exi mia   ⟨d̶h̶a̶s̶k̶a̶l̶o̶⟩.
            only   the Maria has one.F (teacher.M)
            'Only Maria has one.'

The crucial point about (25b) is that it entails that other people have no teacher, male or female, in Katerini, and is judged false if it turns out that Petros has a male teacher. Furthermore, the following sentence with an overt feminine noun is not judged false in such a scenario.

(26)   Mono i   Maria exi mia   dhaskala stin   Katerini.
        only   the Maria has one.F teacher.F in.the Katerini
        'Only Maria has a female teacher in Katerini.'

These data constitute strong support for our analysis that what is elided in (3′a) is a masculine noun, even though D is marked as [feminine]. In addition, (25) gives credence to our hypothesis that [feminine] on D only presupposes the gender and does not assert it, as we assume in (7b).

Now, why is it that a masculine noun with a feminine D is allowed only under ellipsis? We offer an account of this state of affairs, building on the idea that gender-neutral masculine nouns like *dhaskalos* generally compete with the more marked feminine counterpart like *dhaskala*, but this competition does not happen under ellipsis.

3.2. The Principle of Gender Competition

Recall from Section 2 that in Greek (and many other languages), [masculine] is actually unmarked. We have presented evidence that the masculine negative indefinite determiner *kanenan* and masculine marked adjectives are void of gender inferences, for example. This, however, creates a new puzzle: Why is the following sentence unacceptable?

(27)   * I   Maria ine kalos   jatros.
           the Maria is   good.M doctor

If the [masculine] adjective *kalos* does not mean masculine and *jatros* has no gender inferences either, then, semantically speaking, this sentence should be perfectly coherent. However, the sentence is unacceptable. By the same token, according to our semantics for Class III nouns, the following sentence should be semantically coherent, but it is still unacceptable.

(28)   * I   Maria ine dhaskalos.
          the Maria is   teacher.M

In order to account for these examples, we propose that masculine nouns/determiners/adjectives with semantically unmarked gender cannot be used, when their feminine counterparts with non-neutral gender inferences can be felicitously used instead to convey the same meaning. We state this principle as follows.[7]

(29)   *The Principle of Gender Competition*
        Formally, let S and S' be sentences that differ only in that the form of some gendered item, α vs. α'. The use of S in the context c is infelicitous if
        a. α' asymmetrically entails α in the presupposition and/or assertion (in the sense of generalized entailment); and
        b. the presupposition of α' is satisfied in the sentence (i.e. in its local context); and
        c. the assertions of S and S' are contextually equivalent.

More informally, the principle states that given the masculine and feminine forms, the form with more lexical gender specification must be used, whenever it is felicitous and the choice of the gender does not make a difference for the overall meaning.

This explains the unacceptability of (27) and (28) above as follows. These examples are semantically coherent, but they compete with the following sentences, respectively.

(30)   a.   I   Maria ine kali   jatros.
              the Maria is   good.F doctor
       b.   I   Maria ine dhaskala.
              the Maria is   teacher.F

Since these sentences are felicitous and can be used to convey the same meaning, (27) and (28) are made infelicitous.

In addition, the Principle of Gender Competition explains the unmarked behavior of Class II and Class III masculine nouns we saw in Section 2.1. Specifically, when plural, feminine nouns, having lexically specified gender, can only describe female-only pluralities. Plural Class II nouns with [masculine] D and/or A and plural Class III masculine nouns compete with this, but they could be used to describe everything but female-only pluralities, which includes mixed-gender pluralities.

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[7]There is an obvious connection here to the principle of *Maximize Presupposition!* proposed by Heim (1991). However, we observe non-trivial differences, to which we will come back at the end of the paper. We thank Irene Heim (p.c.) for a helpful comment on this.

Similarly, in negative existential sentences, feminine nouns require the domain of quantification to only consist of female individuals. Consequently, Class II nouns with [masculine] D and/or A and class III masculine nouns are felicitously used whenever the domain contains at least one male individual.

Coming back to the data of nominal ellipsis with Class III nouns, the Principle of Gender Competition explains why the version of (3′a) without nominal ellipsis, i.e. (31), is unacceptable.

(31) * O Petros episkefthike enan **dhaskalo** sti   Veria, ke mia   dhaskalo stin
         the Petros visited   one.M teacher.M in.the Veria, and one.F teacher.M in.the
         Katerini.
         Katerini

         'Petros visited a male teacher in Veria, and a female teacher in Katerini.'

Although semantically coherent, this sentence is rendered unacceptable due to the following acceptable sentence.

(32)   O Petros episkefthike enan **dhaskalo** sti   Veria, ke mia   dhaskala stin
        the Petros visited   one.M teacher.M in.the Veria, and one.F teacher.F in.the
        Katerini.
        Katerini

        'Petros visited a male teacher in Veria, and a female teacher in Katerini.'

Then, why is the version of the same sentence with nomininal ellipsis, namely (3′a), acceptable? We propose that under ellipsis, the Principle of Gender Competition is simply inactivated. Then, (3′a) has no competitor, and since semantically coherent, it can be used to mean what it is intended to mean.

Finally, the unacceptability of (3′b) is explained without further ado as follows. Under the intended reading, the sentence means Petros visited a female teacher of his in Veria, and a male teacher in Katerini. This simply cannot be the meaning, if the elided noun is the feminine noun *dhaskala*, because it has a lexically specified gender. Thus, it can only mean Petros visited a female teacher of his in Veria and a female teacher in Katerini. However, under this reading, the use of the masculine determiner *enan* is blocked, as it is overt and competes with the following version of the sentence, which is acceptable.

(33)   O Petros episkefthike mia **dhaskala** sti   Veria, ke mia   ⟨dhaskala⟩ stin
        the Petros visited   one.F teacher.F in.the Veria, and one.F (teacher.F) in.the
        Katerini.
        Katerini

'Petros visited a female teacher of his in Veria, and a female teacher in Katerini.'

Consequently, under either interpretation, (3′b) is rendered unacceptable.

4. Conclusion and Further Issues

To sum up, we proposed the denotations of the three classes of gendered nouns such that only Class I nouns and Class III feminine nouns have lexically specified gender inferences, while for other 'gendered nouns', the gender inference arises due to the Principle of Gender Competition. We argued, furthermore, that the behavior of Class I and Class II nouns under nominal ellipsis straightforwardly falls out from their denotations, under an independently motivated assumption that mismatches in the presuppositions triggered by φ-features are tolerated under ellipsis. Moreover, we claimed that on the assumption that the Principle of Gender Competition does not apply to elided nouns, the nominal ellipsis data involving Class III nouns are also explained.

Before closing, we would like to mention two remaining issues. One concerns grammatical gender, which Merchant (2014) also mentions as a potential problem for his analysis. He observes that ellipsis with gender mismatches is not possible with human-denoting neuter nouns, of which Greek has several (e.g. *koritsi* 'girl', *melos* 'member', *pedhi* 'child', *agori* 'boy'; see Spathas 2010 for related discussion). This is demonstrated by (34).

(34)   * I   Eleni ine ena kalo   koritsi, ala i   Maria ine mia kakia ⟨k̶o̶r̶i̶t̶s̶i̶⟩.
        the Eleni is   a.N good.N girl.N, but the Maria is   a.F bad.F (girl.N)
        (intended) 'Eleni is a good girl, but Maria is a bad one.'

The unacceptability here does not immediately follow from our analysis, because the structure of the sentence should be essentially identical to the masculine-feminine case we discussed in detail. Notice also that all the gender presuppositions should satisfied in this sentence.

One way to account for this state of affairs might be to assume an independent syntactic constraint that specifically targets grammatical gender and forces DP-internal concord even under ellipsis. This would rule out (34), because the second conjunct here involves a grammatically neuter noun but the other materials in DP bear [feminine]. Importantly, in order to rule in felicitous cases of nominal ellipsis with gender mismatches we discussed above, the constraint needs to be sensitive to the distinction between natural gender and grammatical gender. That is, for natural gender, this constraint does not apply and concord is simply not required to the extent that the Principle of Gender Competition is satisfied. If on the right track, this implies that syntax treats natural gender and grammatical gender separately, despite the fact that morphology does not make a clear distinction between natural and grammatical gender. Analyses along these lines are in fact suggested by some scholars, such as Alexiadou (2004) and Kramer (2014), but we will refrain from making an explicit connection here, and leave the issue open for future research.

Another remaining issue has to do with the nature of the Principle of Gender Competition. Previous studies on the unmarkedness of [masculine] relative to [feminine] make recourse to the following more general principle, rather than a gender specific principle like ours.[8]

(35)   *Maximize Presupposition! (MP)*
       Sentence S is infelicitous in context c if there is an alternative S' such that

    a. S and S' assert the same thing in the assertion (i.e. they Strawson-entail each other);

    b. S' has a stronger presupposition than S; and

    c. the presupposition of S' is satisfied in c.

The intuition behind MP is that given two expressions such that they mean the same thing but one has more presuppositions than the other, the one with more presuppositions needs to be used. This makes similar predictions as our principle, but there is one crucial difference. Specifically, MP, as formulated above, actually does not explain (28) under our analysis of Class III nouns, because the masculine and feminine forms differ in the assertive meaning. That is, its feminine counterpart (30b) does not assert the same thing as (28).

This issue could be solved by omitting the first clause of MP. This modification is actually put forward by Spector and Sudo (2014) on completely independent grounds.[9] Let's call this principle MP⋆ (Spector and Sudo call it the Presupposed Ignorance Principle). MP⋆ correctly renders (28) unacceptable in relation to (30b). Furthermore, we can incorporate our proposal that competitions do not happen under ellipsis as follows:

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[8]The principle was originally proposed by Heim (1991), and has been subsequently refined by Percus (2006); Chemla (2008); Percus (2010); Heim (2011); Singh (2011), and Schlenker (2012), among others. These refinements are unnecessary for our discussion, although one case that requires such a refinement is the following:

(1)   * I   Maria ine kali   dhaskalos.
            the Maria is   good.F teacher.M

Here , the gender presupposition is overall the same as that of the acceptable sentence:

(2)   I   Maria ine kali   dhaskala.
        the Maria is   good.F teacher.F
        'Maria is a good teacher.'

One way to account for this is by forcing MP to apply at every 'local context', as proposed by Singh (2011), but see Percus (2006, 2010) for a different analysis (which is closer to how our Principle of Gender Competition is formulated). Another relevant point here is that a different version of MP uses contextual equivalence, rather than mutual Strawson-entailment in the first clause, but we will not be concerned with this difference here.

[9]To compensate for this, proper restrictions on what counts as an alternative to prevent overgeneration are needed. Although such a general theory of alternatives is yet to be developed (see e.g. Katzir 2007; Fox and Katzir 2011; Breheny et al. 2016), it is a theoretical possibility that with an appropriate theory of alternatives, the first clause of MP becomes superfluous to begin with.

(36) *Maximize Presupposition!** (MP**)*
      A sentence S is infelicitous in context c if there is an alternative S' such that

   a. The presuppositions triggered by overt items in S' are stronger than the presuppositions triggered by overt items in S ; and

   b. the presuppositions of S' are satisfied in c.

This could be used to explain our crucial data (3′). However, there are reasons to be cautious about making this move, as MP** makes predictions that are not as straightforward as one might expect.

MP is used to explicate various types of inferences in addition to gender inferences. Let us go through some concrete cases. For instance, a prototypical case of MP involves indefinite vs. definite articles with singular nouns such that the use of an indefinite article generates an inference that the definite counterpart cannot be used, i.e. the uniqueness inference of the definite article would not be met (Heim, 1991, 2011). Concretely, suppose that it is commonly known that John's aeroplane has two engines, and Bill's has only one (thanks to Clemens Mayr, p.c. for discussion on these examples). Then, we have the following contrast.

(37) a.   John's aeroplane lost an engine.
      b.   ?? Bill's aeroplane lost an engine.

The (mild) infelicity of (37b) is considered to be due to the acceptability of the definite (possessive) phrase, *its engine*. Now observe that with a VP ellipsis, this violation is obviated (again assuming total identity under ellipsis).

(38) John's aeroplane lost an engine. Bill's aeroplane did ⟨lose an engine⟩, too.

This is expected under our modification of MP. However, a significant confound here is that the overt version of the above sentence is not at all deviant, unlike (37b).[10] It seems that in cases like this, considerations about parallelism somehow override the competition between indefinites vs. definites, making our predictions impossible to test. Essentially the same considerations apply to other cases that allegely involve MP, e.g. *both* vs. *all*.

Notice that such obviation effects are not observed with masculine vs. feminine gender. As mentioned in Section 2, it is often assumed (e.g. Heim 2008; Percus 2006; Sauerland 2003, 2008) that masculine pronouns have no gender presuppositions and compete with feminine pronouns, which do have gender presuppositions. But having a masculine pronoun in a parallel sentence doesn't make it possible to use a masculine pronoun with a feminine antecedent. More concretely, the second sentence of the following example does not have a bound pronoun interpretation.

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[10]We thank Orin Percus (p.c.) for helpful discussion on this point. See also Percus (2010) for related observations.

(39)   John likes his hometown. Mary likes his hometown, too.

If MP is the principle behind all these phenomena, it remains puzzling why such a difference exists between gender inferences and the inferences of determiners.

In addition, there is at least one case that does not behave as expected under MP**. Specifically, *think* and *know* are considered to constitute a pair that MP operates on, in addition to *a* vs. *the* and *all* vs. *both* (Percus, 2006; Chemla, 2008). That is, *know*, but not *think*, has a factive presupposition, and whenever the factive presupposition is satisfied, the use of *think* is infelicitous. For example, assuming that John, but not Bill, has been admitted to MIT, we observe the following contrast.

(40)   a.   # John thinks that he has been admitted to MIT.
       b.   Bill thinks that he has been admitted to MIT.

Unlike in the examples above, however, the infelicity of (40a) is not saved by a parallel structure with or without ellipsis.

(41)   a.   Bill thinks that he has been admitted to MIT.
            #John thinks that he has been admitted to MIT, too.
       b.   Bill thinks that he has been admitted to MIT.
            #John does ⟨thinks that he has been admitted to MIT⟩, too.

For these reasons, we leave it open whether the Principle of Gender Competition could be reduced to a more general principle like MP.

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Vagueness, Overlap, and Countability[1]

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Abstract. We propose a novel semantic analysis of the mass/count distinction, within a new framework combining the theory of mereology with Probabilistic Type Theory with Records, Prob-TTR (Cooper et al. 2014)). While the notions akin to VAGUENESS (Chierchia 2010) and OVERLAP (Landman 2011) are needed to ground this distinction, neither on its own is sufficient to accommodate the whole range of data, especially the puzzling intra- and crosslinguistic variation in count vs. mass encoding. This variation becomes tractable, if we generally treat the grammatical differences between mass and count nouns as following from the interaction of two notions: namely, VAGUENESS sharpened in terms of graded (probabilistic) type judgements, and DISJOINTNESS relative to a probability threshold. As a result, in the form-denotation mappings, this leads us to a novel semantic classification of nouns into four classes. The mass/count distinction is a bipartite grammatical distinction manifested in the standard diagnostics like a direct combination with numerals, the indefinite article and quantifiers like *every, much*, among others.

Keywords: mereology, mass/count distinction, probabilisitic semantics, vagueness.

1. Introduction

A major challenge for any semantic account of the mass/count distinction in nouns is to account for intra- and crosslinguistic variation in grammatical mass/count encoding. For languages with a grammatically encoded mass/count distinction, some nouns are fairly universally encoded as either MASS or COUNT. Mass nouns of this sort tend to be prototypical substance nouns (*air*, *water*, *mud*). Count nouns of this sort tend to be prototypical object nouns (*chair*, *car*, *girl*, *cat*). However, there are a very large number of nouns for which variation in mass/count encoding is rife. For example, we have the approximate synonyms in (1)–(4):[2] .

(1) *furniture*$_{-C}$; *huonekalu-t*$_{+C,PL}$ (Finnish); *meubel-s*$_{+C,PL}$, *meubilair*$_{-C}$ (Dutch).

(2) *kitchenware*$_{-C}$; *Küchengerät-e*$_{+C,PL}$ (German, lit. kitchen device-s).

(3) *lentil-s*$_{+C,PL}$; *linse-n*$_{+C,PL}$ (German); *lešta*$_{-C}$ (Bulgarian); *čočka*$_{-C}$ (Czech).

(4) *oat-s*$_{+C,PL}$, *oatmeal*$_{-C}$; *kaura*$_{-C}$, *kaurahiutale-et*$_{+C,PL}$ (Finnish, lit. oat.flake-s).

Focusing on such data, in this paper, we examine two influential analyses of the mass/count distinction. One offered by Chierchia (2010), which takes it to be a matter of vagueness. We will

[2] Subscripts $+C$ and $-C$ indicate COUNT and MASS respectively.

show that on Chierchia's vagueness based account, we are forced to give two disparate explanations for the variation in "fake" mass nouns, such as those in (1)–(2), and "granular" nouns, such as those in (3)–(4). Largely inspired by an attempt to improve on Chierchia (2010), the other account is that of Landman (2011). It relies on the notion of overlap, and while it provides a better account of "fake" mass nouns, it still lacks any proposal for why we see variation in "granular" nouns, such as those in (3)–(4).

Although the notions akin to VAGUENESS (Chierchia 2010) and OVERLAP (Landman 2011) are needed to ground the mass/count distinction, neither on its own is sufficient to accommodate the whole range of puzzling intra- and crosslinguistic variation in count vs. mass encoding. This variation becomes tractable, as we argue, if we generally treat the grammatical differences between mass and count nouns as motivated by the interaction of two notions: namely, VAGUENESS sharpened in terms of graded (probabilistic) type judgements, and DISJOINTNESS relative to a probability threshold. This effectively amounts to the innovative claim that the mass/count distinction is dual-source, rather than just mono-source, as is proposed in previous mereologically-based accounts. Assuming this DUAL-SOURCE HYPOTHESIS, we propose a novel semantic account of the mass/count distinction: namely, just as Chierchia (2010) and Landman (2011), it relies on the theory of mereology, but in departure from previous mereologically-based approaches, it enriches mereology with certain assumptions from Probabilistic Type Theory with Records Prob-TTR (Cooper et al. 2014).

In §§2–3, we will introduce the vagueness based theory of Chierchia (2010) and the overlap based theory of Landman (2011). In §4 we argue that both fail to capture intra- and crosslinguistic variation in mass/count encoding and motivate a dual-source hypothesis which predicts four semantic classes of nouns. It turns out that two of these show little or no mass/count variation and two display a large amount. The distinct advantage of our dual-source framework is a much wider data coverage than previous accounts like Chierchia (2010) or Landman (2011), among others, can offer. In §5, we will (very briefly) introduce Type Theory with Records, and its probabilistic variant. In §6 we outline a mereological enrichment of probabilistic Type Theory with Records, detail how vagueness and disjointness are represented in the system, and describe the different semantic properties of the four entity classes. In §7, we summarize these results and suggest some future extensions for our probabilistic mereological approach.

2. Vagueness

Chierchia's (2010) main claim is that mass nouns are vague in a way that count nouns are not. The denotations of count nouns are generated from "stable atoms": It is clear, non-vague, what to count. The denotations of mass nouns are generated from "unstable" individuals: it is vague what the suitable minimal elements are for counting. Taking a simple example, for a count noun like *cat*, we have a reasonably clear idea of what qualifies as a cat atom. Even though *cat* may be vague (when does a cat embryo become a cat?), there are some individuals that will be atoms in the denotation of *cat* no matter how this vagueness is resolved. In contrast, mass nouns like *water* or *rice* are vague in

another way in so far as there is no systematic basis for deciding which water/rice amounts qualify as water/rice atoms. Chierchia attributes this vagueness to a variation in what is semantically an atom in the denotation of mass nouns across contexts:

> "A spoonful of rice is rice. What about a single grain of rice? In many contexts we would not consider a single grain of rice to be enough to reach the threshold of significance. To a child saying she has finished her rice, no parents in their right mind would reply 'no you have not' upon detecting a single grain. Yet for some other purposes we might consider a single grain of rice, rice. But then, that applies to half grains as well. And to quarters of grains." (Chierchia 2010: p. 117)

Chierchia proposes to enrich the mereological structure with a supervaluationist semantics to model this vagueness. Supervaluationism interprets vague NL predicates as including a vagueness band. Relative to a world and a context,[3] a predicate P has a positive extension ^+P, the set of things which count as P, no matter how one might precisify P, and a negative extension ^-P, the set of things which do not count as P, no matter how one might precisify P. The context relative to which ^+P and ^-P is defined is called the *ground context*. If P is vague, then ^+P and ^-P do not form a total partition on the domain. There are elements that sometimes do and sometimes do not count as P depending on the way P is precisified.

Here is a simplified example. Relative to a world and a ground context, the intension of $rice$ will denote a set of objects that are of sufficient quantity to be clear/indisputable cases of rice. For a domain $\mathbf{D} = \{a, b, c, a \cup b, a \cup c, b \cup c, a \cup b \cup c, d\}$, where '$\cup$' is a mereological sum, assume that $^+rice = \{a \cup b \cup c\}$. Further, assume that the negative extension of $rice$ is d (some non-rice): $^-rice = \{d\}$. Since $rice$ is vague, there are ways to precisify its meaning. Precisifications are total partitions of the domain. They form a partial order in that each precisification is either a positive or a neutral extension of the denotation of ^+rice. In the current case, for the total precisification contexts c_0, c_1, c_2, if:

$$
(5) \quad
\begin{aligned}
rice_{c_0} &= & \{a \cup b \cup c\} \\
rice_{c_1} &= & \{a \cup b, a \cup c, b \cup c, a \cup b \cup c\} \\
rice_{c_2} &= & \{a, b, c, a \cup b, a \cup c, b \cup c, a \cup b \cup c\}
\end{aligned}
$$

then c stands in the order $c_0 \propto c_1 \propto c_2$. Chierchia adapts the standard notion of an atom relative to a predicate (6), to an atom relative to a predicate at a ground context (7), and defines stable atoms for a predicate (8) in terms of a definitely operator (9). Atoms relative to each total precisification are given in (10) which means that the set of stable atoms for *rice* is empty. *Rice* has only unstable individuals, not stable atoms.

$$(6) \qquad AT(P) = \{x \in P : \forall y \in P(y \subseteq x \rightarrow y = x)\}$$

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[3]Chierchia employs a form of Data Semantics. As such, his 'contexts' play an equivalent role to 'completions of a partial model' in other forms of supervaluationism.

(7) $$AT_c(P) = \{x \in P^+ : \forall y \in P^+(y \subseteq x \to y = x)\}$$

(8) $$\mathbf{AT}(P) = \lambda x.D[AT(P)(x)]$$

(9) $$[[D\phi]]_c = 1 \text{ iff for all total precisifications } c'\text{of } c, [[D\phi]]_c = 1$$

(10)
$$\begin{array}{rcl}
AT_{c_0}(rice) & = & \{a \cup b \cup c\} \\
AT_{c_1}(rice) & = & \{a \cup b, a \cup c, b \cup c\} \\
AT_{c_2}(rice) & = & \{a, b, c\}
\end{array}$$

Put another way, the intersection of the sets in (10) is empty: there are no stable atoms for $rice$. Counting is counting stable atoms, so $rice$ is MASS.

3. Overlap

A central concept in Landman (2011) is that of a *generator*. The set of generators, $\mathbf{gen}(X)$, of the regular set *X* is the set of *semantic building blocks*, which are either "the things that we would want to count as one" (Landman 2011: p. 26), relative to a context, or are contextually determined minimal parts.[4] If the elements in the generator set are non-overlapping, as in the case of count nouns, then counting is sanctioned: Counting is counting of generators and there is only one way to count. However, if generators overlap, as in the case of mass nouns, counting goes wrong. One of Landman's innovations is to provide a new delimitation of the two cases when this happens, and hence two subcategories of mass nouns: Mess-Mass nouns like *mud* and Neat-Mass nouns like *furniture* (aka "aggregate mass terms" in Payne and Huddleston (2002)). A mass noun is *Neat* if its intension at every world specifies a regular set whose set of minimal elements is non-overlapping. A noun is a *Mess-Mass* noun if its intension at every world specifies a regular set whose set of minimal elements is overlapping.

An example of Mess-Mass noun is *mud*. Relative to a context, there are assumed to be minimal *mud* elements. For the purposes of presentation, let us assume that mud is, roughly, wet dirt, and any minimal element of *mud* must have at least one water component (w_i) and at least one dirt component (d_i), put in the simplest terms. In Figure 1, the minimal elements for mud are highlighted (anything with one dirt and one water component). In this example, the set of minimal elements could equal the set of generators or some superset could, but notice that in either case, the elements of the generator set overlap $((d_1 \cup w_1) \cap (d_1 \cup w_2) \cap (d_2 \cup w_1) \cap (d_2 \cup w_2) \neq \varnothing)$, so *mud* is mass. The minimal elements also overlap, so *mud* is mess. As far as counting is concerned, simultaneously, we have two *variants* of mud of two non-overlapping building blocks: (i) $(d_1 \cup w_1)$ and $(d_2 \cup w_2)$, (ii) $(d_1 \cup w_2)$ and $(d_2 \cup w_1)$. However, it is equally appropriate to regard the mud as being built from $(d_1 \cup w_1)$ and $(d_2 \cup w_2)$ or from $(d_1 \cup w_2)$ and $(d_2 \cup w_1)$. If we count generators we would

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[4]We will discuss this difference in more detail below.

count four entities, if we count variants, we count only two. This clash of answers is the reason why *mud* cannot be counted.
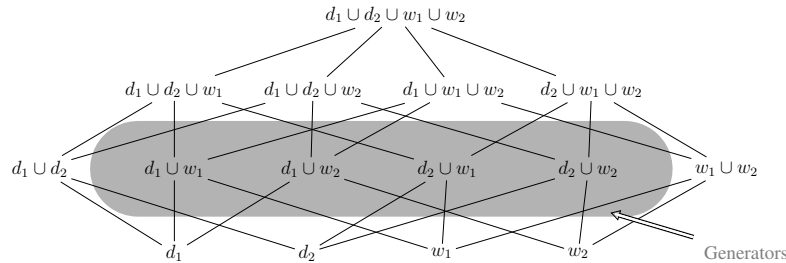
Figure 1: Generators and minimal elements for *mud*
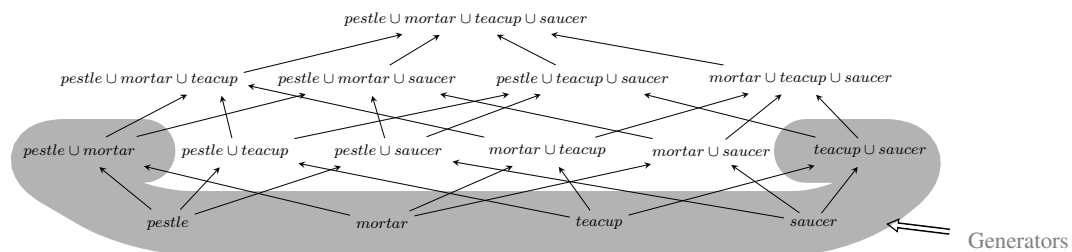
Figure 2: Generators for *kitchenware*

Neat-Mass nouns have a different pattern, illustrated in Figure 2, where the minimal elements of *kitchenware* are a pestle, mortar, teacup and saucer. These are the *non-overlapping minimal generators*. For many purposes, a pestle and a mortar together, and a teacup and a saucer together naturally count as single items of *kitchenware*, in an appropriate context, and so these building blocks are also in the generator set (albeit *not* in the *minimal* generator set). The minimal elements (minimal generators) of *kitchenware* are thus a subset of the generator set. The minimal generators do not overlap ($mortar \cap pestle \cap teacup \cap saucer = \varnothing$), which makes *kitchenware* "neat", but the generator set does, which makes it MASS. Counting goes wrong precisely because the set of generators, i.e., the semantic building blocks that we intuitively want to count as one, includes more than just the minimal elements (generators), namely generators that overlap, as we see in the highlighted area in Figure 2. When we have a pestle, mortar, teacup and saucer, do we have four, three or two items of kitchenware? This clash of answers, due to the fact that both singularities and pluralities can be counted as one simultaneously in the same context, is the reason why *kitchenware* cannot be counted.

4. Vagueness, Overlap and Mass/Count Variation.

Both Chierchia's vagueness-based approach and Landman's overlap-based approach can account for some classes of nouns that were previously not well accounted for in countability research.

Chierchia (2010) is able to explain why nouns which have perceptually salient minimal parts, but are granular in nature (e.g. *rice*) are encoded as MASS. Namely, the perceptually salient parts (the grains) are not stable atoms, but unstable individuals. Landman (2011) is able to address why superordinate/aggregate nouns with clearly salient minimal entities (e.g. *furniture, footwear*) are encoded as MASS. Namely, the perceptual and/or functional parts (items of furniture/footwear) overlap, and so are not defined on the counting function. Despite these clear marks of progress, both accounts face considerable challenges from cross- and intralinguistic mass/count data.

In this section, we will discuss a variety of cross- and intralinguistic data that are problematic for any account defined purely in terms of either vagueness (alone) or overlap (alone). As we explain in §§4.1-4.2 using vagueness as a criterion for count/mass encoding alone or using overlap as a criterion for count/mass encoding alone insufficiently captures the range of relevant data.

4.1. Vagueness is Insufficient

There are vague nouns that are COUNT*:* If *čočka*$_{-C}$ ('lentil', Czech) is vague because, across contexts, what counts as having *čočka*$_{-C}$ varies from lentil dust (severe allergy contexts) up to some larger amount (making lentil soup contexts), then *čočka*$_{-C}$ is MASS. The same should be true for *lentils*, but it is not. *Lentils* is plural COUNT. In other words, the same criteria for count/mass encoding cannot be applied across languages, because there are near synonyms across different languages which are vague in the sense of Chierchia (2010), but that are COUNT in some languages and MASS in others.

Intralinguistically, this single criterion is also insufficient. In British English, (*porridge*) *oats* and *oatmeal* are frequently used as to mean the stuff one buys to make porridge from. These nouns are vague in the sense of Chierchia (2010) because, across contexts, what counts as having *oats/oatmeal* varies from oat dust (severe celiac contexts), up to less than around a cupful (making porridge for breakfast contexts), yet one is MASS and the other is COUNT.

Chierchia (2010) briefly addresses the issue of vague nouns being count:

> "What this suggests is that standardized partitions for the relevant substances are more readily available in such languages/dialects. This type of variation is a consequence of the fact that vagueness comes in degrees: some nouns may well be less vague than others, in the sense that a usable notion of 'smallest sample' can more readily be devised." (Chierchia 2010: p.140)

Although an appeal to degrees of vagueness might explain why one finds crosslinguistic variation in mass/count encoding for vague nouns (different languages have different standards for standardized

partitions), it does not explain the intralinguistic cases. It remains unexplained, on Chierchia's account, why the standards for partitioning shift between uses of, for example, *hair₊C* and *hair₋C* or of *(porridge) oats* and *oatmeal*. In addition, it is not as though usable notions of 'smallest sample' are hard to devise for many of these nouns. For example, in Russian, *kartoška* (potato) is MASS, but potatoes come out of the ground in clearly packaged units. What must be explained is why, despite coming in standardized units, vague nouns may nonetheless be MASS or COUNT.

There are non-vague nouns that are MASS*:* If the Finnish *huonekalu-t₊C* ('furniture') is not vague and therefore COUNT, then the English *furniture* should be COUNT too, but it is MASS. Equally, if vagueness is the only factor in mass/count encoding, we should not expect to find mass/count pairs such as the Dutch *meubel-s₊C*, *meubilair₋C* ('furniture').

Chierchia (2010) is aware of this complexity, and suggests that number marking languages sometimes undergo a copycat process in which a potentially count noun is listed as a singleton property in the lexicon. Although this could be what is behind mass/count variation in non-vague superordinate nouns, we worry that as an explanation it is slightly *ad hoc*. In particular, we should expect to find other instances of 'copycatting' between lexical entires outside of the mass/count distinction, but Chierchia (2010) does not provide any such instances.

More concretely, however, Chierchia's proposal makes a prediction with respect to classifier languages that may be false. Chierchia's account predicts that copycatting should only occur in number marking languages, and that classifier languages should not have "fake" mass nouns. Although classifier languages such as Mandarin Chinese have been argued not to display a mass/count distinction in nouns, but in the classifier system, there is some evidence that superordinates such as the cognate of *furniture* display behavior with classifiers that is distinct from either prototypical count classifiers or prototypical mass classifiers. Cheng (2012) observes that the classifier noun pair *jiàn jiājù* ('piece furniture' Mandarin) behaves by one test more like a count noun and by another more like a mass noun. On the adjective test, *jiàn jiājù* can be modified by *dà* ('big') which patterns with mass constructions. However, it is ungrammatical to include *de* between the classifier and noun which is the pattern of a count construction. Although a more careful analysis of putative "fake" mass nouns in Mandarin and other classifier languages needs to be made, we suggest that at least for *jiàn jiājù* ('piece furniture' Mandarin), there is reason not simply to assume this classifier noun construction is straightforwardly COUNT or MASS. If, as Chierchia's account predicts, copycatting is not possible in classifier languages, at the very least, we would need an extra explanation for this difference which may suggest the possibility of a more parsimonious explanation.

4.2. Overlap is Insufficient

There are overlapping nouns that are COUNT*:* Nouns such as *furniture, kitchenware* have overlapping generators and so are encoded as MASS. However, if such nouns have overlapping entities

that can simultaneously and in the same context 'count as one' it is highly puzzling why cognates *huonekalu-t*$_{+C}$ ('furniture' Finnish) and *Küchengerät-e*$_{+C}$ ('kitchenware', German) should be COUNT. Landman (2011) gives some details for the intralinguistic pair in Dutch, *meubel-s*$_{+C}$ and *meubilair*$_{-C}$ ('furniture'). Where MEUBEL is a disjoint set of items of furniture, and the first in the ordered pair is the generated set, and the second in the pair is the generator set:

meubel	$\rightarrow$	$\langle$MEUBEL, MEUBEL$\rangle$
meubels	$\rightarrow$	$\langle^*$MEUBEL, MEUBEL$\rangle$
meubilair	$\rightarrow$	$\langle^*$MEUBEL,* MEUBEL$\rangle$ (Landman 2011: p. 35)

The neat mass noun *meubilair* has an overlapping generator set, but the single (plural) *meubel(s)* does not. Landman does not discuss what licenses such variation within his system, however, a reason can be given for why this kind of variation is possible. Perhaps cross- and intralinguistic variation occurs for neat mass nouns, but not mess mass nouns. In the above, the count noun *meubel* has non-overlapping *minimal* generators some of which can form the non-overlapping generator set. However, mess mass nouns have overlapping minimal generators, so provide no such basis for enabling a COUNT counterpart. Below, we will build on this thought.

There are non-overlapping nouns that are MASS*:* More problematic for Landman's (2011) account is the following. Presumably, count nouns such as *lentil, bean* must have non-overlapping generators. This is *prima facie* plausible given that the denotations of these granular nouns have clearly perceptible units, namely, individual lentils and beans. However, this makes it highly puzzling why we should find *čočka*$_{-C}$ ('lentil', Czech) and *bob*$_{-C}$ ('bean', Bulgarian). In the neat mass noun case, it was fairly intuitive to think of, say, a cup and saucer sum counting as one item of kitchenware, but with granular nouns is is hard to find any intuitive sense in which, say, two beans or half a bean could count as one bean-item simultaneously and in the same context as a whole bean. Alternatively, one could argue that *čočka*$_{-C}$ ('lentil', Czech) and *bob*$_{-C}$ ('bean', Bulgarian) are mess mass nouns and so have overlapping minimal generators. However, to do so would be to lose the ability to explain mass/count variation as a feature of neat nouns with overlapping generators. We, therefore, consider it better to understand foodstuff granular nouns *rice, lentils, beans* etc., to be neat, but only sometimes MASS. However, this suggests that there may be more to mass encoding than the property of having overlapping generators.

4.3. Summary of Mass/Count Variation Data and a Dual-Source Hypothesis

Table 1 and Table 2 collate some of the data for crosslinguistic and intralinguistic data, respectively. The fields Vague/Not Vague and Overlapping/Not Overlapping should be understood as they are defined in Chierchia (2010) and Landman (2011).

Given the problem cases outlined in §§4.1-4.2, and in considering the way these data group in Tables 1 and 2, a striking pattern emerges.

Table 1: Crosslinguistic Data

	Not Overlapping	Overlapping	
Not Vague	$chair_{+C}$ = $tuoli_{+C}$ (Finnish) = $Stuhl_{+C}$ (German)	$furniture_{-C}$ = $huonekalu\text{-}t_{+C}$ (Finnish)	= $Meubles_{-C}$ (French)
	car_{+C} = $auto_{+C}$ (Finnish) = $Auto_{+C}$ (German)	$kitchenware_{-C}$ = keittiöväline-et$_{+C}$ (Finnish)	= $Küchengerät\text{-}e_{+C}$ (German)
	$girl_{+C}$ = $tyttö_{+C}$ (Finnish) = $Mädchen_{+C}$ (German)	$footwear_{-C}$ = $jalkine\text{-}et_{+C}$ (Finnish)	= $Schuhwerk_{-C}$ (German)
	cat_{+C} = $kissa_{+C}$ (Finnish) = $Katze_{+C}$ (German)	$cutlery_{-C}$ = ruokailuväline-et$_{+C}$ (Finnish) = $Besteck_{-C}$ (German)	
Vague	$rice_{-C}$ = $riisi_{-C}$ (Finnish) = $rýže_{-C}$ (Czech)	mud_{-C} = $muta_{-C}$ (Finnish) = $Schlamm_{-C}$ (German)	
	$lentil\text{-}s_{+C}$ = $linssi\text{-}t_{+C}$ (Finnish) = $čočka_{-C}$ (Czech)	air_{-C} = $lenta_{-C}$ (Finnish) = $Luft_{-C}$ (German)	
	$oat\text{-}s_{+C}$ = $kaura_{-C}$ (Finnish) = $vločky_{+C}$ (Czech)	$blood_{-C}$ = $veri_{-C}$ (Finnish) = $Blut_{-C}$ (German)	
	$bean\text{-}s_{+C}$ = $pavu\text{-}t_{+C}$ (Finnish) = bob_{-C} (Bulgarian)	oil_{-C} = $öljy_{-C}$ (Finnish) = $Öl_{-C}$ (German)	

Table 2: Intralinguistic Data

	Not Overlapping	Overlapping
Not Vague	$chair_{+C}$ vs. $seat_{+C}$ vs. $stool_{+C}$	$meubel\text{-}s_{+C}$ vs. $meubilair_{-C}$ ('furniture' Dutch)
	bus_{+C} vs. $coach_{+C}$	
Vague	$(porridge)\ oat\text{-}s_{+C}$ vs. $oatmeal_{-C}$ (British English)	mud_{-C} vs. $dirt_{-C}$ vs. $grime_{-C}$
	$hair_{+C}$ vs. $hair_{-C}$	oil_{-C} vs. $grease_{-C}$ vs. $lubricant_{-C}$

(i) Those nouns which are vague and show intra- and crosslinguistic variation are the nouns which are non-overlapping.

(ii) Those nouns which are not vague and show intra- and crosslinguistic variation are the nouns which are overlapping.

(iii) Those nouns which are vague and show little or no intra- and crosslinguistic variation are the nouns which are also overlapping.

(iv) Those nouns which are not vague and show little or no intra- and crosslinguistic variation are the nouns that are also not overlapping.

In general terms, the above strongly suggests that although vagueness or overlap alone may enable mass encoding, a single feature alone also allows for count encoding. However, when BOTH vagueness and overlap are present, mass encoding is virtually enforced.

We hypothesize that there is more than mere coincidence to this pattern, and that there is some kind of interaction between vagueness and overlap that combines to block counting. Specifically, we predict that there will be some form of flexibility in the way the denotations of nouns are conceived when only ONE source (vagueness or overlap) is present, but no such flexibility when either BOTH vagueness and overlap are present, or when NEITHER vagueness nor overlap are present.

To test this hypothesis, we develop a formalism that can represent both vagueness and overlap.

However, we will also incorporate some changes to Chierchia's and Landman's accounts. In particular, we will include a broader and richer notion of what 'counts as one' into our account, beyond that of formal atomicity assumed by Chierchia (2010), and we will give a more intuitive formulation of in what way substance mass nouns are overlapping that does not rely on identifying entities that are minimal in context.

5. Type Theory with Records and Probabilistic Type Theory with Records

Type Theory with Records (TTR, Cooper 2012) is a richly typed semantic platform that combines both the rich expressivity of lexical semantic frames (Fillmore 1976) with a compositional semantics in the Montagovian tradition. However, TTR is also helpfully understood as a development of a situation theoretic semantics at least in so far as the truth makers of propositions in TTR are Records which, in application to natural language, should be understood as situations (which are partial) as opposed to possible worlds which are total structures.

TTR includes basic types such as Ind for individual, but also predicates which in the Frege-Montague tradition are n-place functions. For example, the predicate $cat(x)$ is short form for a function $\langle \lambda v.cat(v), \langle x \rangle \rangle$ which takes the value of some label, x, and returns the type of situation in which that individual is a cat. For example if $felix$ is the value for x in a situation, the resulting type would be $cat(felix)$, the type of situation in which felix is a cat.

TTR interprets propositions as types, in particular Record Types such as the one in (11). Propositions have proofs (things which make them true), which in application to natural language semantics are situations or events. The proposition/Record Type in (11) which is the type of situation in which some individual is a cat. Labels x, s_{cat} are provided values by the situation/Record which one is judges to be/not to be of the (Record) Type. As agents, we form judgements as to whether situations are of certain types. So, for example, if a situation, r contains Felix the cat, an agent may judge (truly) that r is of the type in (11). This is expressed in (12).

$$(11) \qquad \begin{bmatrix} x & : & Ind \\ s_{cat} & : & cat(x) \end{bmatrix} \qquad\qquad (12) \qquad r : \begin{bmatrix} x & : & Ind \\ s_{cat} & : & cat(x) \end{bmatrix}$$

In probabilistic TTR, (Cooper et al. 2014, 2015), judgements are probabilistic. Where T is a type, probabilistic judgements are of the form $p(a : T) = k$ where $k \in [0, 1]$. Below we assume Cooper et al.'s implementation of the probabilistic variant of TTR into a simple Bayesian learning model. An agent A records a set of probabilistic judgements $\mathfrak{J}$ from her learning data and calculates the probabilities of new judgements from the information she has in her judgement set. Judgement sets evolve as the agent is exposed to new judgements made, for example by competent speakers. The value k in (13) will represent the prior probability an agent A has for some individual being a cat, given her judgement set $\mathfrak{J}$. Conditional probabilities are then computed as in (14) using a type theoretic version of Bayes' Rule where $||T||_{\mathfrak{J}}$ is the sum of all probabilities associated with T in $\mathfrak{J}$.

$$(13) \quad p_{A,\mathfrak{J}}(r : \begin{bmatrix} x & : & Ind \\ s_{cat} & : & cat(x) \end{bmatrix}) = k \qquad (14) \quad p_{A,\mathfrak{J}}(s : T_1 | s : T_2) = \frac{||T_1 \wedge T_2||_{\mathfrak{J}}}{||T_2||_{\mathfrak{J}}}$$

6. Probabilistic Mereological Type Theory with Records (probM-TTR)

The simple enrichment of prob-TTR we make is replace the type Ind, the basic type for individuals, with the basic type $^*Ind$ which has a domain of 'stuff' which may include substances, individuals, their parts and sums thereof. Formally, the domain of $^*Ind$ will be represented as a whole Boolean semilattice closed under sum.[5] A learner's task will be to establish what, if anything, the individuals denoted by a particular predicate are. For example, given a world full of stuff, a learner of the predicate cat must learn which portions of stuff are individual cats. The type of individual for a predicate P will be represented Ind_P.

For languages that have any true mass nouns at all, we take this process of individuation to be a necessary but not a sufficient condition for countability. Individuation is not sufficient because (i) granular mass nouns, such as *rice*, denote stuff that comes in perceptually salient and identifiable units, namely grains; and (ii) aggregate mass nouns like *furniture* also denote stuff that comes in clearly individuable units (functionally if not also perceptually), namely tables, chairs etc. However, individuation is necessary. Substance and liquid nouns denote stuff that does not come in perceptually or functionally individuable units and it is precisely in these nouns we find uniformity in mass encoding for languages that display any form of mass/count distinction at all. We now sketch how the property of being individuable with respect to a predicate can be represented within probM-TTR.

Following some suggestions in Krifka (1995), we want to distinguish between a qualitative criterion of application and a quantitative criterion of application for predicates. Qualitative criteria include, *inter alia*, functional features, color, size, shape, separatedness, and perceptible granularity.[6] We will leave a more thorough investigation of these features for further research, but this large array of non-necessary but highly informative features makes the frame-based aspect of TTR a highly appropriate modeling tool. Quantitative criteria will be represented with a "quantitative" function, which operates on the values of the qualitative criteria of a noun and outputs a natural number (a function of type $(RecType \rightarrow NatNum)$). Given the size, shape, functionality, etc. of some object, stuff, or sum of objects, we can make a judgement about how many individuable entities there are with respect to a predicate. The special case will be where there is one (the output of the quantitative function is 1). When this occurs, the record type represents the type of situation in which there are objects that are individuals with respect to P. In other words, this record type may be abbreviated as the type of P-Individuals (Ind_P).

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[5]This could equally be achieved using sets. For a set of formal atoms $\{a, b, c\}$, the domain of Ind entities would be $\{a, b, c, \{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$

[6]Some of these features are clearly mereotopological in the sense of Grimm (2012). Just how the insights of Grimm's work could be combined within our formalism is a project we intend to pursue.

For simplicity and brevity, for each predicate, we compress all of the qualitative features into one predicate P_{Qual}. The Record Type for the qualitative and quantitative criteria for applying a predicate P will contain: a record type containing P_{qual}; the specification of a quantitative function labelled as $f_{P_{quant}}$; and a condition stating that the function, when applied to the record type yields a natural number value i. A schema for such a type is given in (15), and an example assuming a numerical measure of 1 is given for the predicate $rice$ in (16)

$$(15) \begin{bmatrix} s_{p_{stuff}} & : & \begin{bmatrix} x & : & {}^*Ind \\ s_{p_{qual}} & : & P_{Qual}(x) \end{bmatrix} \\ f_{p_{quant}} & : & (\begin{bmatrix} x & : & {}^*Ind \\ s_{p_{qual}} & : & P_{Qual}(x) \end{bmatrix} \to \mathbb{N}) \\ i & : & \mathbb{N} \\ s_{p_{quant}} & : & f_{p_{quant}}(s_{p_{stuff}}) = i \end{bmatrix} \quad (16) \begin{bmatrix} s_{rice_{stuff}} & : & \begin{bmatrix} x & : & {}^*Ind \\ s_{rice_{qual}} & : & rice_{Qual}(x) \end{bmatrix} \\ f_{rice_{quant}} & : & (\begin{bmatrix} x & : & {}^*Ind \\ s_{rice_{qual}} & : & rice_{Qual}(x) \end{bmatrix} \to \mathbb{N}) \\ s_{rice_{quant}} & : & f_{rice_{quant}}(s_{rice_{stuff}}) = 1 \end{bmatrix}$$

The special case where the value of the quantitative function with respect to a predicate is 1 yields the type for an individual of that predicate. In other words the record type in (16) is the type for single grains of rice. This type can be abbreviated as $[x : Ind_{rice}]$.

These Ind_P types already allow us to mark a difference between substance/liquid nouns and all other concrete nouns. Perceptual and functional features of the denotations of nouns, we assume, allow one to infer what 'counts as one' in the denotation of the relevant noun. On the perceptual side, this, in part, involves identifying bounded units (what Grimm (2012) refers to as *Maximally Strongly Self Connected* entities). These include whole cats and apples, as well as, for example, whole lentils or rice grains. On the functional side, one might identify multiple bounded entities that jointly perform some function. For example, a pestle and mortar could be inferred to count as one item of kitchenware. However, for substance nouns such as *mud, blood* there are none of the consistent perceptual or functional cues to infer what counts as one that there are with prototypical count nouns, granular nouns, or aggregate nouns. From our probabilistic learning perspective, this will translate as high degrees of uncertainty as to what would be of the type Ind_P when P is a substance predicate. For example, for mud, there will be no a such that an agent would judge a high value for $p(a : Ind_{mud})$.

6.1. Contextual Variation, Vagueness, and Uncertainty in probM-TTR

In the supervaluationism of Chierchia (2010), contexts play the role of precisifications in other forms of supervaluationism. One begins with a ground context and an extension gap, and contexts create complete classical extensions of partial (vague) predicates. Some problems with supervaluationist approaches are well known. For one, it is unclear why ground contexts should be non-vague when expressions are vague. This is the problem of higher-order vagueness. If it is vague what falls into the extension of $rice$, it should also be vague what falls into the extension of that which is definitely rice. However, on Chierchia's analysis, there is a sharp line between that which is always in the

extension of e.g. *rice*, and that which is in the extension gap (relative to some ground context).

From a situation theoretic perspective, contexts are themselves situations, or in TTR terminology, records. In prob-TTR, judgments about contexts are recorded in agents' judgement sets. Following, approximately, the account of vagueness presented in Sutton (2013, 2015), we will now show how varied learning data (across situations/contexts) can yield uncertainty as to whether to apply a predicate. This form of metalinguistic uncertainty captures vagueness from a probabilistic perspective. As we shall argue, in some cases (such as with 'granular' predicates such as *rice*), even if one is completely clear as to what the individual units relative to a predicate are, one may still be uncertain about applying the predicate to small quantities of these units.

The way vagueness arises for granular nouns is very close to the way informally described in Chierchia (2010), however, we shift his informal observations into a learning setting. A learner is presented with competent speaker judgements with respect to situations, but sometimes the information they get is inconsistent. Here is a simple case:

Situation/context 1: Child learner has eaten all but around 10 or so grains of rice on her plate. Parent says: "You have eaten all of your rice."
Situation/context 2: Child learner spills 10 or so grains of rice from her plate. Parent says: "Oops, you spilled some rice."

The quantity (and potentially quality) of the rice is the same in each case, but the learner gets conflicting information. In Situation 1, she learns that ten or so grains does not count as rice. In situation/context 2, she learns that 10 or so grains does count as rice. From a Bayesian learning perspective, giving equal weight to the parent's assertions, she should assign a probability value of 0.5 that a competent speaker would judge ten or so grains to be rice. Within the probM-TTR framework, when the learner next comes to judge this quantity of rice, she applies Bayes' rule to her judgement set, and is left with a high degree of uncertainty whether or not to judge this quantity to be *rice*. The outcome of this calculation is shown in (17):[7]

$$
(17) \quad p_{A,\Im}(r : \begin{bmatrix} x & : & {}^*Ind \\ s_{rice} & : & rice(x) \end{bmatrix} \mid r : \begin{bmatrix} s_{rice_{stuff}} & : & \begin{bmatrix} x & : & {}^*Ind \\ s_{rice_{qual}} & : & rice_{Qual}(x) \end{bmatrix} \\ f_{rice_{quant}} & : & (\begin{bmatrix} x & : & {}^*Ind \\ s_{rice_{qual}} & : & rice_{Qual}(x) \end{bmatrix} \to \mathbb{N}) \\ i & : & \mathbb{N} \\ s_{rice_{quant}} & : & f_{rice_{quant}}(s_{rice_{stuff}}) = 10 \end{bmatrix}) = 0.5
$$

Larger quantities of rice almost always get judged to be rice, smaller quantities will much less frequently do so. This will lead to a graded slope and an individuation challenge. Larger collections of grains will have a high degree of certainty of being judged to be rice, but larger collections of

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[7]The value, 10, of the quantity function in (17) need not require there to be exactly 10 grains of rice. Larger measure values could be increasingly course grained in this respect.

grains do not provide stable bases for counting, since, at the very least, we are not clearly able to discern larger collections of grains from slightly smaller ones, nor to discern how many multiples of larger numbers of grains are in, say a big bowl of rice. So, in searching for a quantity that is sufficiently certain to be judged $rice$, one is left with something one cannot count. Most importantly, we conclude that this is one way in which contextual variation and conflicting learning data can give rise to mass encoding.

We have made no appeal to ground contexts on this account of vagueness. Furthermore, near certainty as to whether some entities are of some type will gradually fade into ever increasing amounts of uncertainty (for example, for smaller amounts of rice). In contrast to supervaluationism, this effectively removes sharp boundaries for ground contexts, and so alleviates problems associated with higher order vagueness, because totally clear cases of, for example, *rice* will not mark a sharp boundary, but rather the edge of a very gradual slope which eventually leads to the unclear cases.

However, the way of representing granular noun denotations such as in (17) yields two subtly different ways of conceiving of the referents. One can make classifications using, for example, the $rice(x)$ predicate. This leads to a 'de-emphasizing' of the type Ind_{rice}, since the presence of a single grain is not a always a good basis for judging something to be rice. However, alternatively, one may also judge whether some stuff is of the type Ind_P (or in the upward closure of this type under sum). For example, *lentil-s* in English are just as contextually variant as *rice* is with respect to conflicting learning data and so *lentil-s* could be treated the same as rice (as in the Czech *čočka*). However, in the case of *lentils*, English has 'chosen' to use the ready made type we have as learners which can form counting base, namely the type for individual, perceptually salient grains/lentils: Ind_{lentil}. Indeed, languages in general have made choices for various granular nouns on the basis of two alternative strategies. They could emphasize the number neutral predicate (e.g. $rice(x)$). This leads to non-countability in the face of uncertainty generated by contextual variation, since it is highly uncertain that one has rice when one has only one grain in certain situations. Alternatively, languages could emphasize the predicate indexed Ind_P type (e.g. Ind_{lentil}), in which case a lexical item would come to denote only individual grains and be straightforwardly countable. It is because both of these strategies are available that helps to explain, as we propose, why we see such common crosslinguistic variation in the mass/count encoding of granular nouns. Indeed, since both strategies may be useful, this also accounts for why we should expect to find intralinguistic COUNT/MASS pairs for granular nouns such as *(porridge) oats* and *oatmeal*.

Prototypical count nouns are not influenced by contexts in this way. It would be rare in the extreme for a learning data provided by competent speakers to conflict with respect to what are and what are not (whole) cats. Therefore, a learner will have little or no uncertainty about making corresponding cat judgements. In other words, as shown in (18) the probability that a single cat quantity (i.e. a single cat) will be judged to be a cat is high or close to 1:

(18) $\qquad p_{A,\mathfrak{J}}(r : \begin{bmatrix} x & : & {}^*Ind \\ s_{cat} & : & cat(x) \end{bmatrix} \mid r : [x : Ind_{cat}]) \approx 1$

So, whether or not a language 'emphasizes' the type cat or the type Ind_{cat}, the result will be the same, namely, a type with a clear counting base of individual cats.

In contrast, although substance nouns such as *mud* are context sensitive and vague in the same way as granular nouns like *rice*, our model can also explain why we so rarely find languages that encode substance nouns as count. For nouns such as *rice, lentils*, two options were available: emphasize the predicate type $P(x)$, or emphasize the Ind_P type. In the former case, one is left with uncertainty of what to count since the stuff which one is sufficiently certain of being rice comes in fairly large, hard to identify portions. In the latter case, one can count, because one can be highly certain that, say, individual lentils are of the type Ind_{lentil}. No such alternative strategy is available for substance nouns such as *mud*, however. As we argued above, nothing can be clearly judged to be an individuated unit of the relevant Ind_P type when P is a substance predicate. Hence, in contrast to vague granular nouns, no countable type is available.

6.2. Modeling Overlap in probM-TTR

Given our mereological enrichment of prob-TTR, defining overlap is fairly straightforward. In standard mereology, disjointness is a higher order property of predicate denotations. This can be interpreted as a type of types in TTR. To integrate this notion into a probabilistic system, we also introduce the threshold θ as a minimal degree of certainty for making a declarative type judgement. Types can then be judged to be disjoint relative to some, possibly context-sensitive threshold of certainty.

A type T is disjoint relative to a probability threshold θ ($Disj_\theta$):

> IF   there is at least some a such that $p(a : T) \geq \theta$,
> THEN $T : Disj_\theta$ iff, for all a, b such that $p(a : T) \geq \theta$ and $p(b : T) \geq \theta$, if $a \neq b$,
>   then $a \cap b = \varnothing$,
> ELSE   Undefined.

Since non-disjointness gives rise to multiple and inconsistent counting results, we suggest that numeral phrases are semantically restricted to applying to types that are disjoint.[8]

For prototypical count nouns such as *cat*, the related Ind type (Ind_{cat}) will be disjoint, and so countable. For granular nouns in languages that emphasize the Ind type for that noun (such as *lentil-s* and Ind_{lentil} in English), this type is also disjoint and so countable.

For neat mass ("fake" mass) nouns, the story is more complex. Recall that types of the form Ind_P are abbreviations for more complex types which include *inter alia* types of the form P_{Qual} and a quantitative function. Importantly, the quantitative function is a function, and so it should not be

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[8]We do not have the space for a formal description of the semantics of numerals in probM-TTR here.

possible, across situations, for qualitatively identical entities to receive multiple quantity values as the output of the function. However, this is precisely what seems to be required for neat mass nouns. This is because, for example, a pestle and mortar sum should be able to count both as one item of kitchenware and as two. The implication of this is that there is no single quantitative function that can deliver this result. However, when a learner is learning to individuate furniture and kitchenware etc., she will be faced with such conflicting data. The strategy left available to resolve this conflict is to begin to track different quantitative functions for the same predicate such that on one, a pestle and mortar sum will receive a value of 1, and on the other a value of 2. In other words, given the way we see "fake" mass nouns (or their count counterparts) being used, we are forced to learn multiple, inconsistent schemes of individuation where each such scheme will be represented by a different quantitative function. Interestingly, this multiple quantitative function approach seems to describe something akin to 'overlapping simultaneously in the same context' in Landman (2011), and "counting contexts" as described in Rothstein (2010). We leave further investigation of this parallelism to further research.

For "fake" mass nouns, then, rather than being a single type Ind_P, there will be multiple types Ind_{P_i}, each one corresponding to a different individuation scheme. Given that each of these Ind_{P_i} types will relate to a single individuation scheme, then each will be disjoint. Therefore the countability of nouns such as the German *Küchengerät-e*$_{+C}$ ('kitchenware') or the Finnish *huonekalu-t*$_{+C}$ ('furniture') is gained merely by counting relative to a single type of the form Ind_{P_i}. However, allowing multiple Ind types for a single predicate is a matter of lexical choice, a language may encode a generalized Ind type formed as the join of all other Ind types for that predicate:

$$(19) \qquad\qquad Ind_{P_{generalized}} = Ind_{P_i} \vee Ind_{P_{i+1}} \vee ... \vee Ind_{P_n}$$

Generalizing comes at a cost however, since the generalized type will no longer be disjoint. As such, one cannot grammatically count the entities of this type due to the disjointness type restriction on the interpretation of number phrases. It is precisely this that we suggest models why the English *kitchenware*$_{-C}$ and *furniture*$_{-C}$ are MASS.

Substance nouns such as *mud, blood* are not countable for a slightly different reason. Given that we cannot be certain of what the individual entities for substance nouns are, substance Ind types are undefined for disjointness and so, for example, even a single Ind_{mud_i} type will not be disjoint. Of course, one way to boost the probability of something being of a type is to form a more general join type since the probability of an entity being of a join type increases with the number of joins (disjuncts). However, even if it were the case that for some a, $p(a : Ind_{mud_i} \vee Ind_{mud_{i+1}} \vee ... \vee Ind_{mud_n}) \geq \theta$, the resulting type would no longer be disjoint. Hence, substance nouns are not likely to be encoded as COUNT.

This strategy of forming join types and thereby allowing in multiple individuation schemas is perhaps an approximation of what Landman (2011) means by mess mass nouns having overlapping minimal generators. However, on our account we do not need to assume anything like a portion of mud, blood etc., that is minimal at a context.

7. Summary and Conclusions

By pursuing this approach we have made some headway into gaining a greater coverage of the puzzling variation one can observe in intra- and crosslinguistic mass/count variation. We have argued that one should adopt a dual-source approach to semantically modeling the mass/count distinction. In doing so, we have arrived at a formal characterization of four classes of nouns, each of which has distinct semantic properties. These are:

Noun type	Exemplars	Semantic Properties
Individual Object	*cat*, *chair*	Denote entities that are clearly (non-vaguely) classified under the predicate. There are no pressures from conflicting learning data to infer multiple quantitative schemas and so counting is felicitous for the associated Ind_P type.
Aggregates	*furniture*, *huone-kalu-t*$_{+C}$ ('furniture' Finnish)	Denote entities that are clearly (non-vaguely) classified under the predicate. There is pressure to infer multiple quantitative schemas. A language may (i) lexically encode these nouns to a single Ind_{P_i} type at every context in which case, counting is felicitous for each associated Ind_{P_i} type; or (ii) form a generalized join type which is not disjoint in which case the counting is not felicitous.
Granular	*rice*, *lentils*	Denote entities that are not clearly (vaguely) classified under the predicate. There are no pressures to infer multiple quantitative schemas, but entities of the relevant Ind_P type are not clear cases of Ps. A language may (i) Lexically encode only the Ind_P type in which case counting is felicitous for this type; or (ii) Lexically encode the predicate $P(x)$. In this case, entities of the Ind_P type are not sufficiently clear cases of Ps and so cannot form the counting base.
Substance	*mud*, *blood*	Denote entities that are not clearly (vaguely) classified under the predicate. No entities are clearly of any of the relevant Ind_{P_i} types. There is nothing to count for any particular Ind_{P_i} type, and if anything is clearly of the more generalized join type, this type is not disjoint and so not defined for counting.

In effect, we have outlined strategies for ignoring vagueness and ignoring overlap. For Individual Object nouns, there is no overlap or vagueness to ignore and so these nouns are straightforwardly countable. For Aggregates, if overlap is ignored, the lexical item is countable. If overlap is not ignored, the lexical item will not be countable. For Granular nouns, if vagueness is ignored, the lexical item is countable. If vagueness is not ignored, the lexical item will not be countable. For Substance nouns, neither strategy for ignoring vagueness/overlap succeeds. This is due, mainly, to the difficulty in inferring any clear entities as individuals for these substances. Hence, our learning driven account derives four semantic classes of nouns. For two of these we expect stable count/mass encoding, for the other two, we expect to find a large amount of cross- and intralinguistic mass/count

variation.

We plan to investigate the ways in which our probabilistic mereological approach could be extended. For example, we have restricted our discussion only to concrete nouns, and we shall investigate whether concepts such as vagueness and overlap can be translated into the abstract domain, and how. Furthermore, while argue for four semantic classes of nouns, we tacitly assume a binary morphosyntactic distinction between COUNT and MASS. However, a further line of research would be to investigate whether our four semantic classes form a correspondence with the four classes proposed in Grimm's (2012) scale of individuation.

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Focus Association and the Scope of Superlative *-est*

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Abstract.   We offer evidence from Bulgarian that when the superlative quantifier *-est* undergoes QR from a DP into the clause, it obligatorily associates with focus, whereas when *-est* QRs internally to the superlative DP, it may but does not have to associate with focus.

Keywords: superlatives, relative readings, QR of *-est,* focus association, clitics

1.   Introduction

Superlative expressions are known to give rise to ambiguities. In (1a-b), from Ross (1964: 36), *the biggest house* is interpreted relative to two different comparison sets, as specified in the *of*-PPs. These different interpretations of superlatives have come to be known as ABSOLUTE and RELATIVE: for the former, the comparison set is determined just on the basis of the DP containing the superlative expression; for the latter, expressions external to the superlative DP are taken into consideration (here *John* – called THE ASSOCIATE – and the property of owning a house).

(1)   John has the biggest house …
    a. … of all those in this area.
    b. … of all my friends from school.

How the absolute and relative readings come about has been a matter of some debate. Two factors have been identified as relevant – the LF scope of the superlative degree quantifier and focus – although their exact role remains unresolved.

1.1 Scope

Heim (1985) and Szabolcsi (1986), a.o., have argued that the ambiguity is structural: the absolute reading results when the degree quantifier (for convenience, *-est*[1]) takes scope within the superlative DP, as in (2a), and the relative reading obtains when the degree quantifier moves out of the superlative DP into the clause, as in (2b). In the latter case, the superlative DP is posited to

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[1] For Szabolcsi (1986), the degree quantifier is *the-est*. See also Krasikova (2012). We can also think of the superlative quantifier itself as non-overt, with the morpheme *-est* marking the type of Deg head introducing the quantifier.

be semantically indefinite. A further step of QR of the associate (here *John*) is required, so that the degree quantifier *-est* can have the same lexical semantics in the two structures.

(2)   a. John has [$_{DP}$ the *-est*$_1$ [$_{NP}$ d_1-big house]]
       b. [$_{TP}$ John$_2$ *-est*$_1$ [$_{TP}$ t_2 has [$_{DP}$ a [$_{NP}$ d_1-big house]]]]

The comparison set is determined based on the denotation of the constituent to which *-est* adjoins as it QRs, and is then further contextually restricted. Formally, this is encoded through a domain argument of the degree quantifier, a null predicate variable, C, whose value is restricted based on the context (as is the case with quantifiers in general) and in accordance with the presuppositions in (3) (Heim 1999).

(3) $\llbracket$*-est*$\rrbracket = \lambda C_{\langle e,t \rangle}.\ \lambda D_{\langle d,et \rangle}.\ \lambda x_e.\ \exists d\ [D(d)(x) \wedge \forall y \in C\ [y \neq x \rightarrow \neg(D(d)(y))]]$

       -est $(C)(D)(x)$ is defined iff (i) $x \in C$, and (ii) $\forall y\ [y \in C \rightarrow \exists d\ [D(d)(y)]]$

In the case of (2a), the comparison set consists of contextually relevant houses with the gradable property of size, as in (4a); the absolute reading of the superlative sentence is that the biggest of those houses is the one John owns. In the case of (2b), the comparison set consists of contextually relevant people who have houses with the gradable property of size, as (4b); the relative reading of the superlative sentence is that among these people the person who owns the biggest house is John.

(4)   a. John has [$_{DP}$ the [*-est* C]$_1$ [$_{NP}$ d_1-big house]]
           $C \subseteq \{$x: x is a house of some size$\}$
       b. [$_{TP}$ John$_2$ [*-est* C]$_1$ [$_{TP}$ t_2 has [$_{DP}$ a [$_{NP}$ d_1-big house]]]]
           $C \subseteq \{$x: x is person who has a house of some size$\}$

In contrast, Farkas and Kiss (2000), Sharvit and Stateva (2002), Coppock and Beaver (2014), a.o., have proposed that the absolute and relative readings obtain from the same structure, with the degree quantifier taking DP-internal scope as in (2a)/(4a), and contextual restriction alone determining the comparison set for the two readings. On both the absolute and relative interpretation the comparison set is the contextually relevant set of houses (with the gradable property of size), as in (4a), in conformity with the LF structure and the presuppositions of *-est*; context alone plays a disambiguating role.

A hybrid account is proposed in Pancheva and Tomaszewicz (2012) and Tomaszewicz (2015a,b): in English, the definite-marked superlative DP precludes QR of *-est,* and so both the absolute and

relative readings are derived through DP-internal scope for *-est*, as in (2a)/(4a), whereas in Slavic, indefinite-marked superlatives allow QR of *-est* into the clause, and so can derive relative readings, as in (2b)/(4b). As argued in Tomaszewicz (2015a), the reason English superlatives block QR of the superlative quantifier *-est* into the clause is that they are necessarily interpreted as semantically definite (see also Coppock and Beaver 2014). We will assume that the hybrid account is correct, and will not repeat the key empirical facts that motivate it, or the details of the formal analysis. We are interested here in differences between relative readings obtained when *-est* has DP-internal vs. DP-external scope. Specifically, we address the question of the role of focus, and its interaction with scope, in deriving relative readings.

1.2 Focus

Prosodic focus is known to have a disambiguating effect on relative readings (Ross 1964, Jackendoff 1972, Szabolcsi 1986, Heim 1999, Farkas and É. Kiss 2000, Sharvit and Stateva 2002, a.o.). In (5) and (6) the available relative reading is determined by prosodic prominence (compare (5b) and (6b)), but the absolute reading is not affected ((5a) and (6a) are the same).

(5)   [JOHN]F bought the biggest house in January.
       a. In January, John bought a house that is bigger than any other relevant house.
       b. In January, John bought a bigger house than any other relevant person did.

(6)   John bought the biggest house in [JAnuary]F.
       a. In January, John bought a house that is bigger than any other relevant house.
       b. In January, John bought a bigger house than he did at any other relevant time.

The facts in (5) and (6) suggest that F-marking on the associate plays a role in the derivation of relative readings, however, the data in (7) complicate the picture. Elements that are not prosodically prominent, *who* or its trace in (7a) (from Szabolcsi 1986) and the null subject in (7b) (from Heim 1999), are relevant for the determination of the comparison set and the available relative reading, and moreover, this happens in the presence of prosodic prominence on other constituents in the sentence. The lack of correspondence between prosodic focus and putative F-marking leads Szabolcsi (1986) and Heim (1999) to conclude that focus is not needed for the derivation of relative readings.

(7)   a. We should console the girl who got the fewest [LEtters]F.
       b. How does one win this contest? - By putting the tallest [PLANT]F on the table.

What seems to be relevant in (5)-(6) vs. (7) is the position of the F-marked constituent: when it is external to the superlative DP, as in (5) and (6), it has an effect on the determination of the comparison set and thus on the available relative reading, but when it is internal to the superlative DP, as in (7), it does not. In other words, prosodic focus on a constituent external to the superlative DP is not compatible with a different constituent being the associate, but given that DP-internal constituents cannot be associates in definite superlatives (Pancheva and Tomaszewicz 2012), prosodic focus DP-internally cannot determine relative readings.

1.3   Goals of this paper

We provide evidence from Bulgarian that when the superlative morpheme *-est* scopes out of superlative DPs, it necessarily associates with focus. When *-est* scopes within the superlative DP, in the presence of the definite determiner, *-est* may but need not associate with focus. This accounts for the two facts from English presented above: (i) focus insensitivity of absolute readings of superlatives, (ii) the optionality of focus with relative readings in English. Since both absolute and relative readings in English are derived with DP-internal QR of *-est*, the lack of obligatory focus association for *-est* in this language follows. The facts are also compatible with claims in Tomaszewicz (2013, 2015a,b) that in Polish, when *-est* takes scope in the clause, it obligatorily associates with focus.

2. Bulgarian superlatives

Bulgarian has both definite- and indefinite-marked superlatives, as in (8) and (9). Absolute readings obtain only with definite-marked superlatives, as in (8a) – the comparison set in (8a) is the set of contextually relevant houses without consideration of who, if anyone, bought them. Certain relative readings are possible with both types of superlatives, as in (8b) and (9b) – here the contextually relevant individuals who bought houses are taken into consideration for the determination of the comparison set. The kind of relative readings available with the two types of superlatives vary: only constituents external to the superlative DP can determine the comparison set with definite-marked superlatives (thus only (8b), set with respect to the associate *Ivan*, is an available relative reading), whereas both DP-external and DP-internal constituents can determine the relative reading with indefinite-marked superlatives (as in (9b)-(9c)). The relative reading in (9c), set with respect to the DP-internal constituent *house*, relies on a comparison set including relevant objects bought by Ivan. This relative reading is absent not just in Bulgarian definite-marked superlatives but from English superlatives as well (Pancheva and Tomaszewicz 2012). On the hybrid account, this reading can only obtain if *-est* QRs into the clause, but such an LF is blocked with definite superlatives for semantic reasons (Tomaszewicz 2015a).

(8)   Ivan kupi   *naj*-goljama-*ta*   kăšta.
       Ivan bought   est-big.FEM.SG-the.FEM.SG   house.FEM.SG
       'Ivan bought the biggest house.'

   a. Ivan bought a house that is bigger than any other relevant house.
   b. Ivan bought a bigger house than any other relevant person did.
   c. *not available*: Ivan bought a bigger house than any other relevant thing he bought.

(9)   Ivan kupi   *naj*-goljama   kăšta.
       Ivan bought   est-big.FEM.SG   house.FEM.SG
       'Ivan bought the biggest house.'

   a. *not available*: Ivan bought a house that is bigger than any other relevant house.
   b. Ivan bought a bigger house than any other relevant person did.
   c. Ivan bought a bigger house than any other relevant thing he bought.

The similarities in available readings between Bulgarian and English definite-marked superlatives suggest that the two should be given the same analysis. And given that Bulgarian has both definite- and indefinite-marked superlatives, an analysis where on relative readings the definite determiner is not interpreted with its usual semantics, but is instead indefinite, is particularly unlikely – the language has a superlative structure with an indefinite determiner. Finally, the fact that the absolute reading obtains only with the definite-marked superlative in Bulgarian, (compare (8a) and (9a)), also suggests that the definite and null indefinite determiners in Bulgarian superlatives are semantically contentful.

The Bulgarian facts thus strengthen the claims of the hybrid account that in English, superlatives are always interpreted as definite, and both absolute and relative readings obtain from an LF where *-est* scopes within the superlative DP.

2.1   Clitic pronouns and focus

Bulgarian has full and clitic object pronouns. The full pronouns are necessarily interpreted as focused: they are prosodically prominent, they are felicitous as the new information in answers to *wh*-questions, and they can be associates to focus-sensitive adverbs like *only* and *even*.[2] The

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[2] In sentences like (10) the full pronoun must be the associate of *only/even*. In sentences where no clitic pronoun may appear, e.g., in PPs, the full pronoun may but does not need to be the associate of the focus-sensitive adverbs.

(i) a. Ivan samo/daže   govori s   [NEja]F   v   kinoto
        Ivan only/even   spoke with   her-FULL.PRON.ACC   in cinema.the
        'Ivan only/even spoke to HER at the movies.'

    b. Ivan samo/daže   [goVOri]F   s   [NEja]F   v   kinoto
        Ivan only/even   spoke   with   her-FULL.PRON.ACC   in cinema.the
        'Ivan only/even SPOKE to her at the movies.'

    c. Ivan samo/daže   govori   s   [NEja]F   v   [KInoto]F
        Ivan only/even   spoke   with   her-FULL.PRON.ACC   in cinema.the

clitic pronouns cannot be stressed, cannot be the new information in answers to *wh*-questions, and they also cannot be associates to *only* and *even*.

(10) a. Ivan pokani [*NEja*]$_F$ na kino.
    Ivan invited her-FULL.PRON.ACC to cinema
    'Ivan invited HER to the movies'
    (also felicitous as an answer to *Who did Ivan invite to the movies?*)

 b. Ivan samo/daže pokani [*NEja*]$_F$ na kino.
    Ivan only/even invited her-FULL.PRON.ACC to cinema
    'Ivan only/even invited HER to the movies'

(11) a. Ivan *ja* pokani na kino.
    Ivan her-CLITIC.ACC invited to cinema
    'Ivan invited her to the movies'
    (not felicitous as an answer to *Who did Ivan invite to the movies?*)

 b. Ivan samo/daže *ja* pokani na kino.
    Ivan only/even her-CLITIC.ACC invited to cinema
    not available: 'Ivan only/even invited HER to the movies'
    'Ivan only inVIted her to the movies', or
    'Ivan only invited her to the MOvies' (depending on which constituent is prominent)

The same facts obtain with full and clitic pronouns in indirect object position, and as possessives. We next ask whether clitics can be associates in relative readings of superlatives in Bulgarian.

2.2 DP-internal associates

The hybrid account derives the relative reading in (9c) – where the comparison set is determined relative to a DP-internal associate – through QR of *-est* into the clause. The reading is not available in (8), or in English, because the definite determiner leads to a semantic problem, as discussed in Tomaszewicz (2015). With that in mind, let us consider (12).

(12) Scenario: Ivan is developing methods to restore a canvas, a sculpture, and a tapestry. He has very little money and so he has to prioritize which of these to restore first.

'Ivan only/even spoke to her at the MOvies.'

Šte   započne   săs   skulpturata.
will   begin-3sg   with   sculpture-the
'He will begin with the sculpture.'

a. Razraboti   naj-evtin   metod   za   *nejnata*   restavracija.
   developed-3sg   *-est*-cheap   method   for   her-FULL.PRON.POSS-the   restoration
   'He developed the cheapest method for its restoration.'

b. # Razraboti   naj-evtin   metod   za   restavracijata   *í.*
   developed-3sg   *-est*-cheap   method   for   restoration-the   her-CLITIC.POSS
   'He developed the cheapest method for its restoration.'

c. # Razraboti   naj-evtin-ija   metod   za   *nejnata*   restavracija.
   developed-3sg   *-est*-cheap-*the*   method   for   her-FULL.PRON.POSS-the   restoration
   'He developed the cheapest method for its restoration.'

d. # Razraboti   naj-evtin-ija   metod   za   restavracijata   *í.*
   developed-3sg   *-est*-cheap-*the*   method   for   restoration-the   her-CLITIC.POSS
   'He developed the cheapest method for its restoration.'

Examples (12a-b) involve an indefinite superlative, and (12c-d) a definite one. Of all these examples, only one, (12a), is felicitous in the given context, as it is the only one that can express the relative reading *Ivan developed a cheaper method for its restoration than any other method he developed for the restoration of the remaining objects*. This is a relative reading with the possessive pronoun as the associate. Because the pronoun is internal to the superlative DP, only an indefinite superlative can give rise to this reading, in line with the hybrid approach. This rules out (12c) and (12d). The only difference between the indefinite superlatives in (12a) and (12b) is the form of the pronoun – a full pronoun can function as the associate for the relevant relative reading, but a clitic pronoun cannot.

The LF behind the relative reading set with respect to the DP-internal associate is as in (13). The degree quantifier QRs into the clause and tucks in below the moved associate.

(13) $[_{TP}$ its$_2$ $[$*-est* $C]_1$ $[_{TP}$ he developed $[_{DP}$ a $[_{NP}$ d_1-cheap method for t_2 restoration$]]]]$
        $C \subseteq \{$x: he developed a method of some cost for the restoration of x$\}$

A possible reason for why (12a) can give rise to the LF in (13) but (12b) cannot, is the (im)movability of clitic pronouns. Perhaps clitics cannot undergo QR and so they cannot become the third argument of *-est.* This, however, is unlikely. First, it has been argued that Bulgarian clitics, possessive clitics among them, agree in case and phi-features with possibly non-overt arguments (Pancheva 2004, Harizanov 2014, a.o.). Thus, while we do not expect the clitic itself

to undergo QR, the null pronominal which it doubles, and which is the real (possessive) argument, must be able to undergo QR. Second, examples like (14a) can have the LF in (14b), i.e, the null pronominal argument being doubled by the clitic must be able to raise at LF to become the third argument of *–est*. (14a) can also have the LF in (14c), with the null subject being the third argument of *-est*, confirming that null pronominals can be associates in relative readings of superlatives.

(14) a. Običam   *ja*   *naj*-mnogo.
          loves-3sg   her-CLITIC.ACC   *-est*-much
          'I love her the most.'

     b. [TP her$_2$ *-est*$_1$ [TP I [VP love t_2 [AdvP d_1-much]]]]
     c. [TP *pro*$_2$ *-est*$_1$ [TP t_2 [VP love her [AdvP d_1-much]]]]

If the clitic, or rather its associated null pronoun, can move and become an argument to *-est*, the fact that the LF in (13) is not available for (12b) suggests that another factor is at play. We would like to suggest that this factor is focus. Specifically, the *-est* that moves out of indefinite superlative DPs must associate with focus, and the focused constituent needs to be the associate (the third argument of *-est*). This claim needs to be restricted to *-est* in long-QR configurations, as in (13), given that in (14) *-est* has sentential scope, yet the associate is a clitic.

2.3   DP-external associates

Let us now consider (15).

(15) Scenario: Mary is a first-grader. The teachers are giving out chocolate bars to the students, as awards for performance in various tasks, and Mary receives the biggest chocolate bar of all the kids. She is happy about this, although she also notices that the biggest chocolate bar of all is not awarded to anyone. It was to be given to the kid who did the extra math problems, and none of the kids completed these.

     Maria   se   radva,   zaštoto …
     Maria   refl. be-happy-3sg   because
     'Maria is happy because …'

     a. … dadoha   *naj*-goljam   šokolad   na neja
         gave-3pl   *-est*-big   chocolate   to her-FULL.PRON.ACC
         'They gave her the biggest chocolate bar'

b. # … *í*   dadoha   *naj*-goljam   šokolad
    her-CLITIC.DAT   gave-3pl   *-est*-big   chocolate
    'They gave her the biggest chocolate bar'

c. … dadoha   *naj*-golem-*ija*   šokolad   na neja
    gave-3pl   *-est*-big-*the*   chocolate   to her-FULL.PRON.ACC
    'They gave her the biggest chocolate bar'

d. … *í*   dadoha   *naj*-golem-*ija*   šokolad
    her-CLITIC.DAT   gave-3pl   *-est*-big-the   chocolate
    'They gave her the biggest chocolate bar'

Here too we are comparing indefinite and definite superlatives, with full and clitic pronouns as the potential associates. The reading that will be appropriate given the scenario in (15) is *They gave her a bigger chocolate than they did to any other kid.*

The judgments concerning (15b) are subtle, but this example is less felicitous in the given context than the remaining three examples in (15).[3] Perhaps the subtlety of judgment indicates that there are two LFs associated with (15b) – one with a DP-external *-est*, which requires focus on the associate, and another one with a DP-internal *-est*, which does not. The hybrid account does not state that relative readings with associates that are external to the superlative DP *must* obtain with DP-external scope for *-est* in indefinite superlatives, it only states that they *can*. And, for instance, Tomaszewicz (2015b) argues that certain relative readings in Polish, a language without a definite determiner, arise through DP-internal scope for the superlative quantifier *-est.*

There are considerations, however, that point to a different conclusion for Bulgarian, namely that in indefinite superlatives of the kind discussed here *-est* takes scope in the clause. A requirement to maximize presuppositions would call for the definite determiner to be used when *-est* remains DP-internal, unless we are dealing with cases like (16), discussed in Herdan and Sharvit (2006).

(16)   Every library has a/(#the) most expensive book.

We are on firmer ground with the definite superlatives in (15c-d). The hybrid account derives the relative reading in definite superlatives through DP-internal scope for *-est*. The acceptability of (15d), a definite superlative with a clitic associate, suggests that focus on the associate is not required when *-est* takes DP-internal scope. This is in contrast with the conclusion we reached with respect to example (12): when *-est* takes DP-external scope, the associate needs to be focused. Thus, in the presence of the definite determiner, Bulgarian is like English, relative

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readings with DP-external (but not DP-internal) associates are available and focus is not obligatory. In the absence of the definite determiner, when *-est* is DP-external, focus is obligatory for relative readings.

3. The interaction of *-est* scope and focus

In the presence of an F-marked constituent, the domain argument of *-est*, C, is constrained by the focus association condition, (17), where C' is the domain argument of the focus operator ~ (Rooth 1992, Heim 1999).

(17) Focus association condition: $C \subseteq C'$ (or $C \subseteq \cup C'$) (Rooth 1992)

The superlative quantifier *-est* can associate with focus on a DP-external associate, both from a DP-external and a DP-internal position. However, *-est* can associate with focus on a DP-internal constituent only from a DP-external position.

3.1 DP-internal *-est,* DP-external associate

Let us consider first the case of DP-internal *-est,* with DP-external associate, as in (15c-d). The relevant relative reading we want to derive relies on a comparison set consisting of the chocolate bars that were given to Maria and the other children in her class. This reading can result from either of the LFs in (18) and (19). In both of them the definite determiner binds the individual argument of *-est*, and C is established on the basis of the denotation of the superlative DP, in line with the superlative presuppositions in (3). The LF in (18) involves no focus association, and is thus the structure that underlies (15d), where a clitic pronoun is the associate. Here the comparison class is further restricted contextually (the underlined conjunct).

(18) They gave her [DP the [NP2 [*-est C*]1 [NP1 d_1-big chocolate bar]]]
        $C \subseteq \{x: \exists d \exists y [x$ is a d-big chocolate bar $\wedge$ <u>they gave x to y</u>]\}$

The LF in (19) involves focus association, and thus can underlie (15c) only, where the associate is a full pronoun. The focus interpretation operator ~ attaches at the TP level and the whole superlative DP can QR outside of the scope of ~ (as in Heim 1999). Given the values of C' and C, the focus association condition is met, (19d). Focus association here accomplishes the same task of restricting the comparison set, as the purely pragmatic contextual restriction in (18).

(19) [$_{DP}$ the [*-est C*]$_1$ [d_1-big chocolate bar]]$_2$ [[~ *C'*] [$_{TP}$ they gave [her]$_F$ t_2]]

    a. $C' \subseteq [\![TP]\!]^f \subseteq \{P: \exists y\ [P = \lambda x\ [\text{they gave } x \text{ to } y]\}$

    b. $\cup [\![TP]\!]^f \subseteq \{x: \exists y\ [\text{they gave } x \text{ to } y]\}$

    c. $C \subseteq \{x: \exists d\ [x \text{ is a } d\text{-big chocolate bar}]\}$

    d. $C \subseteq \cup\, C'$

3.2   DP-internal *-est,* DP-internal associate

If *-est* stays DP-internal, a DP internal constituent cannot be the associate, with or without focus. In (20) the focus association condition cannot be met. In (21) and (22), whether or not the associate moves out of the DP, the comparison set is not the set of alternative artworks that are in need of restoration. (See Tomaszewicz 2015a for further discussion). This is why (12c-d) cannot have the intended relative reading.

(20) [$_{TP}$ he developed [$_{DP}$ the [*-est C*]$_1$ [$_{NP}$ d_1-cheap method for [[its]$_F$ [~ *C'*]] restoration]]]

    a. $C' \subseteq [\![its_F]\!]^f \subseteq \{\text{the canvas', the sculpture's, the tapestry's } \dots\}$

    b. $C \subseteq \{x: \exists d\ [x \text{ is a } d\text{-cheap method for the sculpture's restoration}]\}$

    c. $C \nsubseteq C'$

(21) [$_{TP}$ he developed [$_{DP}$ the [*-est C*]$_1$ [$_{NP}$ d_1-cheap method for its restoration]]]

    $C \subseteq \{x: \exists d\ [x \text{ is a } d\text{-cheap method for the sculpture's restoration}]\}$

(22) [$_{TP}$ its$_2$ [$_{TP}$ he developed [$_{DP}$ the [*-est C*]$_1$ [$_{NP}$ d_1-cheap method for t_2 restoration]]]]

    a. $[\![NP]\!]^g = \lambda d\ \lambda x\ [x \text{ is a } d\text{-cheap method for } g(2)\text{'s restoration}]$

    b. $C \subseteq \{x: \exists d\ [x \text{ is a } d\text{-cheap method for } g(2)\text{'s restoration}]\}$

3.3   DP-external *-est,* DP-internal associate

The clear case of DP-external *-est*, (12a), should in principle be derivable from the LF in (13). However, because a clitic is not felicitous as the associate, (12b), we have to augment the LF with focus marking on the associate, as in (23). The associate possessive pronoun is focused, it QRs to the edge of the clause leaving a trace, while *-est* tucks in below it. The focus operator attaches to the associate evoking the alternative set of individuals of which *C'* is a subset, (23b). The focus association condition is satisfied, (23c), because there is no clash between the focal presupposition (23a) and the specification of *C* resulting from the presuppositions of *-est* (23b).

(23) [TP [[its]F [~ *C'*]] [[*-est C*]₁ [TP he developed [DP a [NP d_1-cheap method for *t* restoration]]]]
      a. *C'* ⊆ ⟦itsF⟧^{f} ⊆ {the canvas', the sculpture's, the tapestry's …}
      b. *C* ⊆ {*x*: ∃*d* [he developed a *d*-cheap method for *x*'s restoration]}
      c. *C* ⊆ *C'*

The need for focus on the associate in the case of DP-external *-est* does not seem to follow from any independent constraint.

3.4 DP-external *-est,* DP-external associate

Finally, the indefinite superlatives in (15a-b) allow *-est* to take DP external scope, but as we noted earlier, long QR is not in principle *required*. Yet, the fact that the clitic is not fully acceptable as an associate favors an account involving DP-external *-est,* as in (24). If so, just as in (23) above, obligatory focus-sensitivity needs to be attributed to DP-external *-est*.

(24) [TP [[her]F [~ *C'*]] [TP [*-est C*]₁ [TP they gave *t* a d_1-big chocolate bar]]]
      a. *C'* ⊆ ⟦her⟧^{f} ⊆ {Maria, …}
      b. *C* ⊆ {*x*: ∃*d* [they gave *x* a *d*-big chocolate bar]}
      c. *C* ⊆ *C'*

4. Conclusion

In the last two sections we noted that DP-external scope for *-est* alone can derive relative readings, without F-marking the associate. Yet, the Bulgarian data concerning the availability of clitics as associates in indefinite superlatives suggest that focus is required. The associate must be F-marked, so that its focus alternative value is congruent with the comparison set.

The theory of focus association, according to which focus effects on quantifier domains are the result of the anaphoric dependence on the same background context (i.e. (17) holds when both *C* and *C'* have an antecedent in explicit or implicit discourse), predicts that focus effects are optional. It then follows that phonologically reduced material can still play a role in the specification of the domain of a quantifier. For cases where operators require phonological focus (e.g. *only*), focus association needs to be lexically encoded, otherwise, irrespective of the presence of ~, the domain variable can be contextually resolved (Rooth 1992, Beaver and Clark 2008).

We thus need to treat DP-external *-est* similar to adverbial *only*: they both obligatorily associate with focus. The parallels in fact extend further. DP-internal *-est* and DP-internal *only* optionally associate with focus. An analysis of this observation will have to wait for another occasion.

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High and low readings in indicative donkeys[1]

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Abstract. In this paper, we extend existing accounts of high and low readings in counterfactual donkey sentences (van Rooij 2006, Walker and Romero 2015) to indicative donkey sentences. First, we generalize the account to indicative donkey sentences featuring modals that employ ordering sources. Then, we turn to indicative donkey sentences with adverbs of quantification. We discuss the relationship between high and low readings arising when a similarity measure is involved and symmetric and asymmetric readings arising with adverbs of quantification (Kadmon 1987) and present tentative data that suggests that they are two closely related phenomena.

Keywords: counterfactuals, donkey sentences, conditionals, dynamic semantics, proportion problem.

1. Introduction

1.1. Similarity and counterfactuals

A standard semantics for counterfactuals (Stalnaker 1968, Lewis 1973) considers them true if and only if their consequent holds in the closest antecedent-worlds, where closeness is analyzed in terms of overall similarity. The ordering of worlds by similarity is assumed to be provided by the context, but largely remains underspecified. In this paper, we pursue an insight from the recent literature on so-called 'counterfactual donkey sentences' (van Rooij 2006, Wang 2009, Walker and Romero 2015): the similarity ordering in counterfactuals interacts with indefinite noun phrases in the antecedent in an interesting and crucial way to select the closest worlds to be quantified over. By first investigating this particular interaction, we hope to ultimately shed light on the general pragmatics of similarity orderings. However, in this particular instance we pursue a pragmatic account that is closely tied to the semantics of the indefinite.

The sentences we consider have the form in (1), essentially combining the ingredients of a classical (indicative) donkey sentence (Geach 1962) as in (2) – indefinite noun phrases in the antecedent and pronouns referring back to these noun phrases in the consequent – with the morphological markings of a subjunctive counterfactual conditional[2] as in (3):

> (1)   If a farmer owned a donkey, he would beat it.   *Counterfactual donkey sentence*

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[2]We leave out non-counterfactual subjunctive conditionals discussed in Anderson (1951), Leahy (2011).

(2)   If a farmer owns a donkey, he beats it.   *Indicative donkey sentence*

(3)   If Pedro owned Platero, he would beat it.   *Counterfactual conditional*

van Rooij (2006) offers an account of sentences like (1) in which they are ambiguous between two readings that we call high and low respectively. In Walker and Romero (2015) we defend this account against a criticism by Wang (2009) and develop it further to account for the licencing of Negative Polarity Items (NPIs) in the antecedents of low counterfactual donkey sentences. In the present paper, we will present a brief overview and elaboration on these developments in Section 2 and proceed to extend the analysis in a new direction in Sections 3 and 4. In Section 3, we show that high and low readings also appear in indicative donkey sentences that employ some form of ordering source in their semantics. In Section 4, we relate our account of this phenomenon to the well-known problem of symmetric and asymmetric readings of indicative donkey sentences with quantificational adverbs like *usually* (e.g. Kadmon (1987)). Section 5 concludes.

1.2. Theoretical preliminaries

van Rooij's (2006) analysis of counterfactual donkey sentences combines a standard dynamic account of donkey sentences —namely, dynamic predicate logic (DPL, Groenendijk and Stokhof (1991))— with a standard variably strict analysis of counterfactuals (Stalnaker 1968, Lewis 1973)[3]. The truth conditions of a plain counterfactual conditional like (3) in the Stalnaker-Lewis semantics can be spelled out as follows:

(4) $[\![\phi > \psi]\!]^{f,\leq}(w) = 1$ iff $\forall w' \in f_w([\![\phi]\!]^{f,\leq}) : w' \in [\![\psi]\!]^{f,\leq}$

(5) $f_w([\![\phi]\!])^{f,\leq}) = \{v \in [\![\phi]\!]^{f,\leq} | \neg \exists u \in [\![\phi]\!]^{f,\leq} : u <_w v\}$

That is, the counterfactual *if ϕ, would ψ* is true iff all worlds returned by a selection function f when applied to the world of evaluation w and the antecedent ϕ are such that they also verify the consequent ψ. The function f returns all worlds v that satisfy the antecedent and for which there is no other world u that also satisfies the antecedent and that is more similar to the actual/evaluation world than v. The ordering of worlds $\leq$ is assumed to be provided by the context.

Groenendijk and Stokhof's (1991) DPL is a standard solution to the problem of establishing the correct binding relations in donkey sentences. It assumes that donkey sentences are standardly translated into a formula with open variables, as in (6), but modifies the underlying logic such

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[3]In Walker and Romero (2015) we argue for using a strict conditional framework with a modal horizon (von Fintel 2001) instead of the variably strict analysis. This allows us to derive the correct facts about NPI licensing in low counterfactual donkeys. As this analysis is independent of the discussion in this paper, we use the simpler variably strict analysis for the purpose of exposition here.

that this formula turns out to be equivalent to the correct reading of donkey sentences that native speakers report, i.e. it ensures that (7) holds. This is achieved by making the meanings of sentences dynamic, that is, by passing the modifications made to assignment functions by a formula on as input to the next formula instead of discarding them, as in (8) - (12) (where $h[x]g$ means that assignment h differs from g at most with respect to the value it assigns to x).

(6) $\exists x[Px] \rightarrow Qx$

(7) $\exists x[Px] \rightarrow Qx \quad \Leftrightarrow \quad \forall x[Px \rightarrow Qx]$

(8) $[\![Rt_1...t_n]\!] = \{\langle g,h \rangle \mid h = g \wedge \langle [\![t_1]\!]_h ... [\![t_n]\!]_h \rangle \in F(R)\}$

(9) $[\![\exists x\phi]\!] = \{\langle g,h \rangle \mid \exists k : k[x]g \wedge \langle k,h \rangle \in [\![\phi]\!]\}$

(10) $[\![\phi \wedge \psi]\!] = \{\langle g,h \rangle \mid \exists k : \langle g,k \rangle \in [\![\phi]\!] \wedge \langle k,h \rangle \in [\![\psi]\!]\}$

(11) $[\![\phi \rightarrow \psi]\!] = \{\langle g,h \rangle \mid h = g \wedge \forall k : \langle h,k \rangle \in [\![\phi]\!] \rightarrow \exists j : \langle k,j \rangle \in [\![\psi]\!]\}$

(12) $[\![\forall x\phi]\!] = \{\langle g,h \rangle \mid h = g \wedge \forall k : k[x]g \rightarrow \exists j : \langle k,j \rangle \in [\![\phi]\!]\}$

The reader is referred to the original paper by Groenendijk and Stokhof (1991) for a detailed discussion of the underlying mechanisms and a proof that this apparatus derives the crucial equivalence in (7). In this paper, we follow van Rooij (2006) in assuming DPL as the framework of our analysis.

2. High and low readings in counterfactual donkey sentences

2.1. The data

Under a standard analysis of counterfactuals, we would expect the truth of a sentence like (13) to only depend on John's attitude towards donkeys in the closest worlds. However, as van Rooij (2006) points out, this is not necessarily the reading that we obtain. Rather, the most salient reading seems to be one that inherits the 'universal flavour' of indicative donkey sentences in that we understand it as entailing the conjunction of (14a)-(14d):

(13)   If John owned a donkey, he would beat it.   *High reading*

(14)   a. If John owned donkey a, John would beat a.

      b. If John owned donkey b, John would beat b.

      c. If John owned donkey c, John would beat c.

      d. ...

We call this reading the *high* reading of counterfactual donkey sentences. It essentially transfers the equivalence assumed for the indicative conditional, see (7), to the counterfactual conditional:

(15) $\exists x[Px] > Qx \quad \Leftrightarrow \quad \forall x[Px > Qx]$

However, we cannot assume that this is the only reading of counterfactual donkey sentences. There are some cases where we clearly do not want the equivalence in (15) to hold:

(16)   If Alex were married to a girl from his class, it would be Sue.   *Low reading*

(17)   a. $\nRightarrow$ If Alex were married to Ann, Ann would be Sue.

      b. $\nRightarrow$ If Alex were married to Betty, Betty would be Sue.

      c. $\nRightarrow$ If Alex were married to Carol, Carol would be Sue.

      d.   ...

We call this reading the *low* reading of counterfactual conditionals[4].

2.2. The account

In order to derive the high / low reading, we follow van Rooij (2006) in assuming that the semantics of the indefinite interacts with the similarity relation. That is, we assume that similarity is not the only factor in deciding which worlds a counterfactual quantifies over. At the core of this account is the move to a dynamic framework in which a counterfactual quantifies not just over worlds, but over pairs of worlds and assignments. The selection function f that was employed in the Stalnaker-Lewis account, see (5), is modified to return such pairs, as in (18). Crucially, in selecting the world-assignment pairs it returns, it optionally partializes the classical similarity ordering by the individuals an indefinite in the antecedent ranges over. The optionality is implemented by a contextually given set X of variables, a subset of the variables introduced by indefinites in the antecedent: if an indefinite noun phrase is interpreted as high, the variable x it introduces will be in set X; if the indefinite is interpreted as low, its variable will not be in X. The impact of X in the ordering of pairs is defined in (19)-(20).

(18) $f^X_{\langle w,g \rangle}(/\phi/_g) = \{\langle v,h \rangle \in /\phi/_g : \neg \exists \langle u,k \rangle \in /\phi/_g : \langle u,k \rangle <^X_{\langle w,g \rangle} \langle v,h \rangle\}$

(19) $\langle v,h \rangle <^X_{\langle w,g \rangle} \langle u,k \rangle$ iff $h,k \supseteq g$, $h \uparrow^X = k \uparrow^X$ and $v <_w u$

(20) $h \uparrow^X = k \uparrow^X$ iff $\forall x \in X : h(x) = k(x)$

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[4]In Walker and Romero (2015) we show that this analysis needs to be supplemented by an analysis of the *it* in the consequent of (16) as either a cleft-construction or a concealed question to account for the invariably neuter form of the pronoun. We also demonstrate that the low reading appears with standard donkey pronouns as well, given rich enough contexts.

The counterfactual then quantifies over the pairs returned by the selection function f, just as in the standard counterfactual semantics[5]:

(21) $\llbracket \phi >^X \psi \rrbracket^{\leq}(\langle w, g \rangle) = 1$ iff $\forall \langle v, h \rangle \in f^X_{\langle w,g \rangle}(/\phi/_g) : \langle v, h \rangle \in /\psi/_g$

That is, the counterfactual is true if and only if, for each individual, the most similar world-assignment pairs that assign this individual to a variable in X is also one that satisfies the consequent.

To demonstrate the way this semantics works, consider the following example sentence (22), where x is the variable introduced by the indefinite *a donkey*, and the toy model in Table 1:

(22) If John owned a^x donkey, he would beat it.

	donkey	own	beat
w_0	$\{a, b, c\}$	$\emptyset$	$\emptyset$
w_1	$\{a, b, c\}$	$\{\langle j, a \rangle\}$	$\{\langle j, a \rangle\}$
w_2	$\{a, b, c\}$	$\{\langle j, b \rangle\}$	$\{\langle j, b \rangle\}$
w_3	$\{a, b, c\}$	$\{\langle j, c \rangle\}$	$\emptyset$
w_4	$\{a, b, c\}$	$\{\langle j, a \rangle\}$	$\emptyset$

Table 1: A sample model for (22), with worlds ranked as follows: $w_0 < w_1 < w_2 < w_3 < w_4$

Under the low reading of the indefinite *a donkey* in (22), its variable x is not in set X. This means that, when selecting the closest pairs to $\langle w_0, g \rangle$, we rank any two pairs $\langle w', h \rangle$ and $\langle w'', k \rangle$ (where $h, k \supseteq g$) that make the antecedent true regardless of what value h and k assign to x. Then, we only quantify over those world-assignment pairs that make the antecedent true and that, according to that global ranking, have as their world the world closest to w_0. In the toy model in Table 1, this amounts to the pair $\langle w_1, g^{a/x} \rangle$, as w_1 is most similar to the actual world. As this pair also verifies the consequent, the counterfactual comes out as true.

Now consider the high reading of (22), where the variable x introduced by *a donkey* is in set X. Under this reading, we rank two world-assignment pairs with respect to each other only if their assignments differ at most in the values of variables introduced in the antecedent that are not in X. Since $X=\{x\}$ in our example (22), only pairs whose assignments are identical with respect to x will be ranked with respect to each other. This means that $\langle w_2, g^{b/x} \rangle$ and $\langle w_3, g^{c/x} \rangle$ will not be ranked with respect to $\langle w_1, g^{a/x} \rangle$, since they do not share an assignment with it, and that $\langle w_2, g^{b/x} \rangle$ and $\langle w_3, g^{c/x} \rangle$ will also count as closest pairs to $\langle w_0, g \rangle$ and thus as candidates for quantification.

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[5]The account in van Rooij (2006) introduces some additional machinery in order to deal with weak readings of the pronoun. For simplicity, we leave this out of the presentation in this paper.

Quantifying over these three pairs, we can see that $\langle w_3, g^{c/x} \rangle$ does not verify the consequent, rendering the counterfactual false. The pair $\langle w_4, g^{a/x} \rangle$ remains irrelevant for the computation: as it shares an assignment with $\langle w_1, g^{a/x} \rangle$, we only quantify over the pair with the closer world, w_1.

2.3. Wang's challenge

Wang (2009) contends that the appearance of high readings in sentences like (13) is in fact illusory and argues for a unified account that only generates the (standardly expected) low reading for counterfactual donkey sentences. It is, in fact, true that in the standard examples high readings entail low readings. This is so because the set of worlds-assignment pairs quantified over in the high reading – which includes the closest world-assignment pair for each relevant individual – is a superset of that quantified over in the low reading – which includes just the closest world-assignment pair in absolute terms. Hence, universal quantification over the former set entails universal quantification over the latter set. This raises the possibility that there is only one genuine reading generated by the grammar – the low reading – and that what is perceived as a high interpretation is simply a subcase of the low reading.

Furthermore, depending on the order among worlds, the high reading does not only (properly) entail the low reading but the two yield in fact the exact same truth conditions. As shown in Walker and Romero (2015), there is a specific condition under which the low reading and the high interpretation end up quantifying exactly over the same world-assignment pairs: when all candidate worlds for a high reading (namely, the closest world for each individual that the indefinite is ranging over) happen to be equally close to the actual world. In the example scenario in Table 1 above, this would amount to assuming that the ordering of worlds is as shown in (23). With this ordering, the low reading and the putative high reading of (22) are indistinguishable.

(23) $w_0 < w_1 = w_2 = w_3 < w_4$

2.4. Contra Wang

In order to test Wang's approach, we proceed in two steps. First, we set up contexts that make an ordering like the one in (23) implausible. This guarantees that the two readings do not converge in the exact same truth conditions[6]. Second, we modify the syntax of the donkey sentence so

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[6]There exists, however, the possibility of designing an account that assumes that similarity is coarse-grained, and that we quantify not only over the closest worlds, but over all that are close enough. The high/low distinction would then be modelled by a shifting threshold of sufficient closeness. However, in the absence of a fully specified version of such an account, we note that modelling the dynamics of the threshold presumably would coincide with our analysis in many, if not all cases. For further discussion of this option, see our conclusion.

that the entailment relation between high and low readings is inverted. We will use two means to achieve this: negation of the entire counterfactual (elaborating on Walker and Romero (2015)) and *might*-counterfactuals.

Let us start with negation. Consider scenario (24), slightly modified from Walker and Romero (2015), which sets a clear distance between the closest worlds in which Onophilos and Onophobos are donkey-owners respectively. The crucial test sentence is the underlined negated counterfactual uttered by the advisor in the dialogue in (25b):

(24)   *Scenario*: There are two farmers in the kingdom of King Kakos, called Onophilos and Onophobos. Both are very poor and do not own a donkey. Onophobos is a cruel man who would love to own and beat a donkey. He has been saving money all his life and has nearly enough to buy a donkey. Onophilos is a mild-mannered vegan who has no means or interest in owning a donkey, much less so in beating it. King Kakos only knows Onophobos and is convinced that all inhabitants of his kingdom are just as cruel and evil as Onophobos. He discusses this with his advisor, who is well-informed about all the farmers and their dispositions.

(25)   a. KING KAKOS: Here's what I think about the farmers in my kingdom. If a farmer in my kingdom was a donkey-owner, he would be a donkey-beater.

       b. ADVISOR: You are wrong. It's not the case that if a farmer in your kingdom was a donkey-owner, he would be a donkey-beater. Onophilos, for example, is a vegan and would never beat a donkey if he owned one.

Under the low reading, this sentence is false in scenario (24). If Wang is right and only the low reading is generated by the grammar, the sentence should be judged false. Under a high reading, the sentence is true. If the grammar makes the high reading available, the sentence should be judged true. Crucially, the empirical intuition is that the sentence is true in this scenario, hence showing that the high reading is generated by the grammar.

Another way of having negation scoping over the entire counterfactual – and perhaps a more natural way to do so – is by making the universal modal operator phonologically overt and letting negation directly precede it. This is done in (26) - (27). The reasoning is the same: the underlined sentence in (27b) is intuitively judged true and thus the high reading is generated by the grammar.

(26)   *Scenario*: Adiaforos doesn't own a donkey but is saving money to buy one. He's most likely to buy affordable Melissa, a stubborn old donkey that Adiaforos would have to beat. Excepting stubborn donkeys, Adiaforos has no inclination to beat donkeys. King Kakos sees that Adiaforos is fetching a stick from the forest.

(27)   a.   KING KAKOS: I see that Adiaforos likes beating donkeys and is preparing for it.

      b.   ADVISOR: <u>If Adiaforos owned a donkey, he wouldn't necessarily beat it.</u> It depends on which one he buys.

Let us now consider *might*-counterfactuals, which are standardly analysed as existentially quantifying over the closest worlds that make the antecedent clause true (Lewis 1973). By using existential rather than universal quantification, the entailment relation between the two readings is reversed: existential quantification over the subset set arising in the low reading – the set containing the closest world-assignment pairs in absolute terms – will always entail existential quantification over the superset set arising in the high reading – the set containing the closest world-assignment pairs per individual. The relevant scenario and sentence are given in (28) - (29):

(28)   *Scenario*: Adiaforos doesn't own a donkey but is saving money to buy one. He's most likely to buy Platero, a sweet- tempered donkey that Adiaforos would never beat. Other than that, Adiaforos has nothing against beating regular stubborn donkeys. King Kakos sees that Adiaforos is preparing a comfortable donkey stable.

(29)   a.   KING KAKOS: I see that Adiaforos loves donkeys.

      b.   ADVISOR: <u>If Adiaforos owned a donkey, he might very well beat it.</u> It depends on which one he buys.

Again, if the grammar only generates the low reading, the underlined counterfactual in (29b) should be judged false in scenario (28). If the grammar also generates the high reading, the sentence should be judged true. Since the sentence is in fact intuitively true, the grammar generates the high reading.

We conclude from this data that our semantics needs to account for both high and low interpretations of counterfactual donkey sentences independently.

3. High and low readings in indicative donkey sentences with modals

3.1. The data

Although the semantics we have presented so far is derived from a semantics for counterfactual conditionals, we note that the observations extend to indicative donkey sentences, as long as they contain some form of modality that employs an ordering source. This is expected under a Kratzer-style analysis of conditionals: the similarity ordering we employ in counterfactual conditionals is simply a specific case of an ordering source (specifically, a totally realistic ordering source over an empty modal base.) Some examples for this are the following:

(30)   Epistemic modality:

    a.   I don't know if Tino owns a donkey, but if he owns a donkey, he beats it.   *High*

    b.   I don't know if Tino owns a donkey, but if he owns a donkey, it is Grisella.   *Low*

Example (30a) readily allows for a high reading. Note that, while keeping with the high reading of the indefinite, (30a) is ambiguous between a weak and a strong reading of the donkey pronoun, where Tino either beats all of his donkeys (strong) or one/some of his donkeys (weak). The reading in (30b) is distinct from both of these, however: we neither convey that all of his donkeys are Grisella, nor that one of his donkeys is Grisella. Rather, it has a low reading of the indefinite indicating that Grisella is the most likely donkey to be owned by Tino (if he owns any.)

Parallel examples can be constructed with deontic modality, witness (31a)-(31a):

(31)   Deontic modality:

    a.   If Afiadoros buys a donkey, he has to treat it well.   *High*

    b.   If Afiadoros buys a donkey, it has to be Platero.   *Low*

3.2. A generalized account

Assuming that conditionals have a roughly unified analysis, with the counterfactual as a subcase with a realistic ordering source and an empty modal base (Kratzer 1991, Portner 2009), we straightforwardly generalize to other modals with any modal base and ordering source:

(32) $\llbracket \phi \to^X \psi \rrbracket^{\leq^{\mathrm{OS}}, \mathrm{MB}}(\langle w, g \rangle) = 1$ iff $\forall \langle v, h \rangle \in f_{\langle w, g \rangle}^{X, \mathrm{MB}, \leq^{\mathrm{OS}}}(/\phi/_g) : \langle v, h \rangle \in /\psi/_g$

(33) $f_{\langle w, g \rangle}^{X, \mathrm{MB}, \leq}(/\phi/_g) = \{\langle v, h \rangle \in (\mathrm{MB} \cap /\phi/_g) : \neg \exists \langle u, k \rangle \in (\mathrm{MB} \cap /\phi/_g) : \langle u, k \rangle <_{\langle w, g \rangle}^X \langle v, h \rangle\}$

That is, for any given ordering source *OS* and modal base *MB*, we intersect the antecedent-worlds with the modal base and use the ordering $\leq$ induced by the ordering source, partialized by the values of X. For the counterfactual case, the modal base is empty (i.e. contains all possible worlds) – rendering the intersection vacuous –, and the ordering induced is our familiar similarity ordering, yielding the semantics we discussed above.

4. High and low readings in indicative donkey sentences with adverbs of quantification: Symmetric and asymmetric readings

A familiar puzzle in indicative donkey sentences is the so-called proportion problem (Kadmon 1987): a sentence like (35) comes out as true in the scenario in (34) under the standard analyses,

because its consequent is true for most farmer-donkey pairs. However, in its most salient reading, the sentence is judged false, because we are counting farmers instead of farmer-donkey pairs.

(34)   *Scenario*: There are ten farmers in this village. One is rich and owns ninety donkeys. The others are poor and own one donkey each.

(35)   If a farmer in this village owns a donkey, he is usually rich.

There is a familiar solution to this puzzle as well (at least in dynamic semantics[7]): give up on the idea of unselective binding and assume that indefinites are marked as either relevant or irrelevant to the counting procedure of the quantificational adverb. This is parallel to the way that indefinites are marked as either relevant or irrelevant for interacting with similarity (i.e., by either being or not being included in a contextually given set X, a subset of the variables introduced in the antecedent). In fact, in developing the mechanism for the latter, van Rooij (2006) directly refers to the former mechanism (e.g. Dekker (1993)). This raises two questions: (i) whether this similarity in theoretical machinery is purely accidental or whether there is an actual empirical connection between the symmetric/asymmetric ambiguity and the high/low ambiguity, and (ii), assuming that there is an empirical connection between the two phenomena, whether the two formal apparatus can be reduced to a single quantificational schema.

We tackle these two questions in the following subsections. As the reader will see, the results in subsection 4.1 are tentative. The merging of the two formal systems in subsection 4.2 is an exercise.

4.1. The empirical question

On the one hand, the symmetric/asymmetric ambiguity is attested with adverbs of quantification but not with modal quantification. This is because, by definition, symmetric and asymmetric readings concern merely quantification over individuals (via assignments), and modals necessarily bring in a world quantification component. On the other hand, the high/low ambiguity arises with modal quantification but not with quantificational adverbs. This is due to the fact that, by definition, the labels 'high' and 'low' identify two ways in which a similarity ordering may be affected by a given indefinite, and quantificational adverbs intuitively make use of no similarity orderings. This means that the two kinds of ambiguity are in complementary distribution. But, then, how can we test whether they are, empirically, the same phenomenon?

Here is an idea. There are some linguistic devices that enforce or at least prime one of the two readings in one of the two quantificational environments. Now, if the same linguistic device that forces or primes the indefinite to be irrelevant (for similarity/for counting) in one environment also

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[7]For a related solution in D-type theory, see Walker (2014).

forces or primes the indefinite to be irrelevant (for similarity/for counting) in the other environment, then it would be most parsimonious to assume that the two kinds of ambiguity are two surface exponents of the same underlying phenomenon.

We will examine two such linguistic devices. The first one is identificational sentences like (36). As discussed in section 2.1, in modalized (counterfactual) conditionals, an identificational consequent identifying the referent of an indefinite (*a girl from his class* in the antecedent clause) enforces the low reading of that indefinite, i.e., it forces the indefinite to be irrelevant for interacting with similarity, so that the high reading and its entailments in (37) are lost:

(36)   If Alex were married to a girl from his class, it would be Sue.   *High / ✓ Low*

(37)   a. ⇏ If Alex were married to Ann, Ann would be Sue.

      b. ⇏ If Alex were married to Betty, Betty would be Sue.

      c. ⇏ If Alex were married to Carol, Carol would be Sue.

      d. ...

Now let us take a non-modalized example with an adverb of quantification and make the consequent clause identificational: (38). The question is whether this device —which triggers irrelevance for similarity in modal contexts— triggers irrelevance for counting in quantificational adverb contexts as well. The answer is 'yes': (38) cannot be paraphrased as in (38a).

(38)   If(/when) a man calls, it is usually John.

      a. # 'For most x: if x calls, x is John.'

The second linguistic device is topicality. It has been noted that, in indicative donkey sentence with adverbs of quantification, making a given indefinite topical favours an asymmetric reading where the topical indefinite is relevant for counting and non-topical indefinites irrelevant (Chierchia 1992). This is illustrated in (39). The small discourse makes farmers topical. As a result, the donkey sentence readily has the asymmetric reading (39a) counting farmers but, crucially, not the asymmetric reading (39b) counting donkeys. That the latter reading is not (readily) available is shown by judging the sentence in scenario (40): scenario (40) would verify the donkey-counting asymmetric reading (39b) —and falsify (39a)—, but the sentence is judged false in it.

(39)   Let me tell you something about farmers in this county. If a farmer knows a donkey well, he usually respects it.

      a. 'Most donkey-knowing farmers respect those donkeys.'

      b. # 'Most known-to-farmers donkeys are respected by those farmers.'

(40) Scenario: There are five donkeys and five farmers. The first four donkeys are known to
      farmer Bill, who respects them. The fifth donkey is known to the other four farmers, who
      disrespect it.

Now let us take an example of modalized (counterfactual) conditional and mix it with topicality.
This gives us (41). The question is, again, whether this device —which triggers irrelevance of
the non-topical indefinite for counting in adverb-of-quantification contexts— triggers irrelevance
for similarity in modal contexts as well. Though the judgments are somewhat subtle, the answer
seems to be 'yes': (41) can be readily understood as having the entailments in (41a), but not so the
entailments in (41b). This is apparent when the sentence is judged against scenario (42). In this
scenario, the entailments in (41b) are verified: for each individual donkey, it is most likely that it is
known by farmer Bill, who would also respect it. But (41) is judged false in this context, showing
that the reading is unavailable.

(41) Let me tell you something about farmers in this county. If a farmer knew a donkey well,
      he would respect it.
      a. Reading with *a farmer* as high indefinite and *a donkey* as low indefinite:
            i. $\Rightarrow$ If farmer f_1 knew a donkey well, f_1 would respect it.
            ii. $\Rightarrow$ If farmer f_2 knew a donkey well, f_2 would respect it.
            iii. $\Rightarrow$ If farmer f_3 knew a donkey well, f_3 would respect it.
            iv. ...
      b. Reading with *a farmer* as low indefinite and *a donkey* as high indefinite:
            i. $\Rightarrow$ If a farmer knew donkey d_1 well, he would respect d_1.
            ii. $\Rightarrow$ If a farmer knew donkey d_2 well, he would respect d_2.
            iii. $\Rightarrow$ If a farmer knew donkey d_3 well, he would respect d_3.
            iv. ...

(42) Scenario: None of the farmers knows any donkey well. But farmer Bill is the farmer that
      knows donkeys best and, since he has a lot of respect for intelligent animals, he would
      have a lot of respect for a donkey if he knew it well. All the other farmers are much
      less knowledgeable about donkeys and, as they don't respect smart animals, they wouldn't
      respect donkeys if they knew them.

These preliminary data suggest that (ir)relevance for similarity and (ir)relevant for counting are,
empirically speaking, not unrelated. Of course, it remains an open question whether the two phe-
nomena are truly underlyingly the same or whether they correspond to two different semantic
processes that happen to be affected in the same way by the same linguistic devices. But, in the
absence of evidence to the contrary, it seems most economical to aim at a unified analysis of the
two. This takes us to our next section, where the two formal mechanisms are unified.

4.2. The formal exercise: Towards a unified analysis

Dekker (1993) assumes that adverbs of quantification take two propositions and use them to construct two sets of assignments that are related by the respective set-theoretic interpretation of that adverb of quantification. This is shown in (43). Crucially, each assignment j in the first set of assignments is an extension of an input assignment i and differs from it only in that values for the variables contained in the contextually supplied variable X have been added ($i \sqsubseteq_X j$). These extended assignments j, if they also verify the antecedent, are then compared with the assignments that survive updates with both the antecedent and the consequent. If the quantificational adverb is *always*, all the assignments in the first set are required to also be in the second set, as defined in (44).

(43) $\quad s[A_X(\phi, \psi)] = \{i \in s \mid [A] \, (\{j \mid i \sqsubseteq_X j \wedge j < s[\phi]\}) \, (\{j \mid j < s[\phi][\psi]\})\}$

(44) $\quad [\text{always}](J, K) = 1 \quad \text{iff} \quad \forall j \in J : j \in K$

The goal of this subsection is to unify the two formal apparatus of donkey quantification: Dekker (1993)'s approach via adverbs of quantification and the present account in sections 2 and 3 via modal quantification. We will proceed in three quick steps. First, we will extend and modify Dekker's idea to account for counterfactual donkeys. Once we have the modified interpretation template, we will go back to indicatives donkeys with adverbs of quantification and minimally enrich them. Finally, we put all the ingredients together in a unified account of high/low and symmetric/asymmetric readings across counterfactual and indicative donkeys.

First, to extend Dekker's idea to our counterfactual case, we treat *would* (or the universal modal behind it) in a parallel way to quantificational adverbs. However, since we are dealing with an intensional framework, we have to enrich Dekker's (1993) proposal and assume that the information states are not simply sets of assignments, but instead sets of world-assignment pairs, as in van Rooij (2006)[8]. We can then give the semantics as follows:

(45) $\quad s[\text{would}_X(\phi, \psi)] = \{\langle w, i \rangle \in s \mid [\text{would}]_{\langle w, i \rangle}(\{\langle w', j \rangle \mid i \sqsubseteq_X j \wedge \langle w', j \rangle < s[\phi]\})$
$\qquad (\{\langle w', j \rangle \mid \langle w', j \rangle < s[\phi][\psi]\})\}$

(46) $\quad [\text{would}]_{\langle w, i \rangle}(J, K) = 1 \quad \text{iff}$
$\qquad \forall \langle w', j \rangle \in J : (\neg \exists \langle w'', j \rangle \in J : w' <_w w'') \to \langle w', j \rangle \in K$

That is, *would* behaves in a parallel way to quantificational adverbs and only differs in the way it relates the two sets of world-assignment pairs provided to it. Specifically, it asserts that all the

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[8]Dekker (1993) sketches a possible extension of his system that essentially makes this move by adding a designated world variable to every assignment.

closest antecedent-verifying pairs in the set J are also in the set K. Note that —differently from our semantics in sections 2 and 3— there is no need to make the ordering relation itself sensitive to X, as we did with $\leq^X_{\langle w,g \rangle}$ in (19). Rather, we simply compare pairs that share an assignment, as defined in (46). This is because the sensitivity to X is already encoded in the construction of the set J in (45), as in Dekker's (1993) account of asymmetric quantification.

Second, let us go back to adverbs of quantification. Since we have modified our information states so that they are now sets of world-assignment pairs, we need to recast the interpretation template for adverbs of quantification as involving such pairs. We propose (47)-(48). The idea is that adverbs of quantification like $always$ are grounded to the actual/evaluation world and thus only quantify over world-assignment pairs whose first member is the evaluation world.

(47) $\quad s[A_X(\phi,\psi)] = \{\langle w,i \rangle \in s \mid [A]_{\langle w,i \rangle} (\{\langle w',j \rangle \mid i \sqsubseteq_X j \ \wedge \ \langle w',j \rangle \lessdot s[\phi]\})$
$\quad\quad (\{\langle w',j \rangle \mid \langle w',j \rangle \lessdot s[\phi][\psi]\})\}$

(48) $\quad [\text{always}]_{\langle w,i \rangle}(J,K) = 1$ iff
$\quad\quad \forall \langle w',j \rangle \in J : w' = w \rightarrow \langle w',j \rangle \in K$

Finally, generalizing this to the whole range of phenomena – i.e. symmetric/asymmetric quantification with adverbs of quantification, low/high readings in counterfactuals and low/high readings in modal indicative donkeys –, we propose the tentative analysis in (49)-(51). Quantifiers on the verbal spine – in this case, modals and adverbs of quantification – are uniformly interpreted via the template (49). Sensitivity to the set X of selected variables is handled here, so that, depending on what shape X has, we will get a different set of world-assignments pairs J. Modals and adverbs of quantification operate on the sets J and K built in (49). On the one hand, modals filter the world-assignment pairs in J with the help of their respective modal bases, order the results via the ordering source and check whether the best of the so ordered pairs are also in set K. On the other hand, adverbs of quantification filter the world-assignment pairs in J so that only those pairs remain where the first element is the evaluation world (as if we had a totally realistic modal base) and then they check whether these remaining pairs are also in K.

(49) $\quad s[\text{Quant}_X(\phi,\psi)] = \{\langle w,i \rangle \in s \mid [\text{Quant}]_{\langle w,i \rangle} (\{\langle w',j \rangle \mid i \sqsubseteq_X j \ \wedge \ \langle w',j \rangle \lessdot s[\phi]\})$
$\quad\quad (\{\langle w',j \rangle \mid \langle w',j \rangle \lessdot s[\phi][\psi]\})\}$

(50) $\quad [\forall\text{-Modal}]^{\leq^{\text{OS}},\text{MB}}_{\langle w,i \rangle}(J,K) = 1$ iff
$\quad\quad \forall \langle w',j \rangle \in J : (\langle w',j \rangle \in \text{MB} \wedge \neg \exists \langle w'',j \rangle \in J \cap \text{MB} : w'' <^{\text{OS}}_w w') \rightarrow \langle w',j \rangle \in K$

(51) $\quad [\forall\text{-Adverb}]_{\langle w,i \rangle}(J,K) = 1$ iff
$\quad\quad \forall \langle w',j \rangle \in J : w' = w \rightarrow \langle w',j \rangle \in K$

To see the system in action, consider the example in (53) and the scenario described in (52) and detailed in Table 2. If we assume that all the pairs in s have an empty assignment g, *a farmer*

introduces the variable x and *a donkey* the variable y, and that $X = \{x\}$ (that is, a high reading for farmers and a low reading for donkeys), we obtain the result in (54). *Would* relates two sets of world-assignment pairs. One contains pairs which differ from the input pairs in that their assignment assigns a value to x and which can be extended to verify the antecedent. This amounts to pairs with worlds w_1, w_2, w_3 and w_4, with g modified to assign the respective donkey-owning farmers a, b and c to x. The other set contains pairs that can be extended to verify both the antecedent and the consequent. Since this is a relatively weak condition, the set in question is much larger, because it contains both extended and non-extended assignments; however, only those that can be extended to verify the consequent are included in this second set (i.e. no pair with world w_2). In the last equation in (54), we can see how *would* relates these two pairs: it requires all closest members of the first set to be included in the second set. As the closeness requirement eliminates the pair $\langle w_2, g^{a/x} \rangle$ – but not the other pairs, as they have distinct assignments –, the condition is fulfilled.

(52)   *Scenario*: Of all the farmers a, b and c, farmer a is most likely to own a donkey, no matter which one. Donkey d is very stubborn and would be beaten by its owner, but e is well-behaved and would not be beaten by its owner.

	farmer	donkey	own	beat
w_0	$\{a,b,c\}$	$\{d,e\}$	$\emptyset$	$\emptyset$
w_1	$\{a,b,c\}$	$\{d,e\}$	$\{\langle a,d\rangle\}$	$\{\langle a,d\rangle\}$
w_2	$\{a,b,c\}$	$\{d,e\}$	$\{\langle a,e\rangle\}$	$\emptyset$
w_3	$\{a,b,c\}$	$\{d,e\}$	$\{\langle b,d\rangle\}$	$\{\langle b,d\rangle\}$
w_4	$\{a,b,c\}$	$\{d,e\}$	$\{\langle c,d\rangle\}$	$\{\langle c,d\rangle\}$

Table 2: A sample model for (53), with worlds ranked as follows: $w_0 < w_1 < w_2 < w_3 < w_4$

(53)   If a farmer owned a donkey, he would beat it.

(54) $s[\text{would}_{\{x\}}(\text{a farmer owns a donkey})(\text{he beats it})]$
$= \{\langle w, i\rangle \in s \mid [\text{would}]_{\langle w,i\rangle}$
$(\{\langle w', j\rangle \mid i \sqsubseteq_{\{x\}} j \wedge \langle w', j\rangle \ll s[\text{a farmer owns a donkey}]\})$
$(\{\langle w', j\rangle \mid \langle w', j\rangle \ll s[\text{a farmer owns a donkey}][\text{he beats it}]\}))\}$
$= \{\langle w, i\rangle \in s \mid [\text{would}]_i$
$(\{\langle w_1, g^{a/x}\rangle, \langle w_2, g^{a/x}\rangle, \langle w_3, g^{b/x}\rangle, \langle w_4, g^{c/x}\rangle\})$
$(\{\langle w_1, g\rangle, \langle w_3, g\rangle, \langle w_4, g\rangle, \langle w_1, g^{a/x}\rangle, \langle w_3, g^{b/x}\rangle, \langle w_4, g^{c/x}\rangle,$
$\langle w_1, g^{a/x,d/y}\rangle, \langle w_3, g^{b/x,d/y}\rangle, \langle w_4, g^{c/x,d/y}\rangle\}))\}$
$= \{\langle w, i\rangle \in s \mid \forall \langle w', j\rangle \in \{\langle w_1, g^{a/x}\rangle, \langle w_2, g^{a/x}\rangle, \langle w_3, g^{b/x}\rangle, \langle w_4, g^{c/x}\rangle\} :$
$(\neg\exists \langle w'', j'\rangle \in \{\langle w_1, g^{a/x}\rangle, \langle w_2, g^{a/x}\rangle, \langle w_3, g^{b/x}\rangle, \langle w_4, g^{c/x}\rangle\} : j' <_w^{\text{OS}} j) \rightarrow$
$\langle w', j\rangle \in \{\langle w_1, g\rangle, \langle w_3, g\rangle, \langle w_4, g\rangle, \langle w_1, g^{a/x}\rangle, \langle w_3, g^{b/x}\rangle, \langle w_4, g^{c/x}\rangle,$
$\langle w_1, g^{a/x,d/y}\rangle, \langle w_3, g^{b/x,d/y}\rangle, \langle w_4, g^{c/x,d/y}\rangle\}\}$

We can run a parallel example for a non-modal indicative sentence. Consider the example (56) and the scenario described in (55) and detailed in Table 3. Assuming again that all pairs in s have an empty assignment g, that *a farmer* introduces the variable x, that *a donkey* introduces the variable y and that $X = \{x\}$ (i.e. farmers are to be counted, but donkeys are not), we obtain the following. The first set contains pairs with both the actual world w_0 and world w_1, and assignments extended to assign either a or b to x. Since no beating happens in w_1, the second set only contains pairs with the actual world w_0, but again, a larger number of assignments. In the last equation in (57), we see that *always* enforces the following condition: if the world of a pair in the first set is the actual world, then that pair has to be contained in the second set. This removes all the pairs with w_1 and ensures that the conditional is true. Note that only farmers have been counted, as we ignore the fact that donkey e remains unbeaten.

(55) $\quad$ *Scenario*: There are two farmers, a and b, who co-own two donkeys d and e. Both farmers beat stubborn d but not e in the actual world w_0. The same owning relations hold in w_1 but there is no beating in w_1.

	farmer	donkey	own	beat
w_0	$\{a, b\}$	$\{d, e\}$	$\{\langle a, d\rangle, \langle a, e\rangle, \langle b, d\rangle, \langle b, e\rangle\}$	$\{\langle a, d\rangle, \langle b, d\rangle\}$
w_1	$\{a, b\}$	$\{d, e\}$	$\{\langle a, d\rangle, \langle a, e\rangle, \langle b, d\rangle, \langle b, e\rangle\}$	$\emptyset$

Table 3: A sample model for (56), with worlds ranked as follows: $w_0 < w_1$

(56) $\quad$ If a farmer owns a donkey, he beats it.

(57) $\quad$ $s[\text{always}_{\{x\}}(\text{a farmer owns a donkey})(\text{he beats it})]$
$= \{\langle w, i\rangle \in s \mid [\text{always}]_{\langle w, i\rangle}$
$(\{\langle w', j\rangle \mid i \sqsubseteq_X j \wedge \langle w', j\rangle \lessdot s[\text{a farmer owns a donkey}]\})$
$(\{\langle w', j\rangle \mid \{\langle w', j\rangle \lessdot s[\text{a farmer owns a donkey}][\text{he beats it}]\}))\}$
$= \{\langle w, i\rangle \in s \mid [\text{always}]_{\langle w, i\rangle}$
$(\{\langle w_0, g^{a/x}\rangle, \langle w_0, g^{b/x}\rangle, \langle w_1, g^{a/x}\rangle, \langle w_1, g^{b/x}\rangle\})$
$(\{\langle w_0, g\rangle, \langle w_0, g^{a/x}\rangle, \langle w_0, g^{b/x}\rangle, \langle w_0, g^{a/x,d/y}\rangle, \langle w_0, g^{b/x,d/y}\rangle\}))\}$
$= \{\langle w, i\rangle \in s \mid \forall \langle w', j\rangle \in \{\langle w_0, g^{a/x}\rangle, \langle w_0, g^{b/x}\rangle, \langle w_1, g^{a/x}\rangle, \langle w_1, g^{b/x}\rangle\} : w' = w \rightarrow$
$\langle w', j\rangle \in \{\langle w_0, g\rangle, \langle w_0, g^{a/x}\rangle, \langle w_0, g^{b/x}\rangle, \langle w_0, g^{a/x,d/y}\rangle, \langle w_0, g^{b/x,d/y}\rangle\}\}$

5. Conclusions

We have shown that similarity orderings in counterfactuals – and, more generally, ordering sources in modals – are sensitive to some linguistic material in the antecedent of the counterfactual, specifically indefinite noun phrases. This sensitivity gives rise to two different readings, high and low, which can be found in both counterfactual and indicative donkey sentences, contra Wang's (2009)

challenge. We tentatively propose that this phenomenon is closely related to the proportion problem and sketch a unified analysis of both phenomena, but leave further exploration of this issue to future research.

This is only a partial account of ordering sources in that there may be many other factors that pragmatically interact with the orderings we use. But it isolates one specific interaction and gives a systematic account of it. This distinguishes it from a potential account that would explain the data by appealing to the granularity of similarity, e.g. by selecting not just the closest worlds, but the closest worlds up to a contextually determined threshold of similarity. Note that an account of this type could only quantitatively shift the domain of quantification: where our account predicts that we can target specific worlds that are less similar if they are closest for a particular individual, a threshold-based account, if it wanted to include this world in the quantification, would have to include all other worlds that are equally or more similar, in terms of overall similarity.

If the question of asymmetric readings and the high/low distinction are as closely related as our data suggests, we are faced with the challenge of further developing these results, not only in terms of a formal account, but also in terms of interpreting it. Both issues can indeed be viewed as showing a certain kind of granularity in our quantificational behaviour, although different from the threshold-based view: what we observe here is a complex partitioning of quantificational domains (of both individuals and worlds) based on more or less fine-grained classes of assignments, not just a question of including more or less worlds in the quantification.

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Deriving *the most* internal relative reading[1]

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Abstract. Definite-marked constructions with adnominal quantity superlatives (*most, least, fewest*) give rise to both NP-external and NP-internal relative readings in English, while other adnominal superlatives allow only NP-external readings. Neither the movement approach to relative superlatives (Szabolcsi 1986, Heim 1999) nor Pancheva & Tomaszewicz's (2012) combined movement-and-*in-situ* approach can account for this pattern of available readings. To explain how it is derived, I propose a novel constituency for constructions with adnominal quantity superlatives, which is motivated by findings in the parallel domain of measure phrases.

Keywords: internal relative readings, pseudopartitives, superlatives, stratified reference

1. Introduction

Superlatives are famously ambiguous between the absolute reading and various relative readings that are sensitive to focus. Pitch accent on either *Anne* or *that bakery* in (1) makes salient the (NP-external) relative readings paraphrased in (1a,b) below, in contrast to the absolute (1c).

> (1) *Anne gets the best cake from that bakery.*
>   a. 'Anne gets better cake from that bakery than anyone else does.'
>   b. 'Anne gets better cake from that bakery than from anywhere else.'
>   c. 'Anne gets cake from the that bakery that is better than any other cake.'

Hackl (2009) treats the ambiguity between proportional and relative *most* analogously, decomposing it into *many + est*. The relative readings (2a,b) require the presence of the definite article, while the proportional reading (2c) requires its absence.

> (2) *Anne gets (the) most cookies from that bakery.*
>   a. 'Anne gets more cookies from that bakery than anyone else does.'
>   b. 'Anne gets more cookies from that bakery than from anywhere else.'
>   c. 'Anne gets the majority of cookies from that bakery.'

A different kind of relative reading for *most* becomes possible if an element internal to the superlative NP is focused. To set the context for this reading, let me recount a memorable experience that I had when visiting friends in Berlin.

Clemens shares my love of sweets, and Füsun was 8 months pregnant at the time, so they were both eager to introduce me to the local *Kuchenbuffet* – a café where you can pay €5,50 for a cup of coffee and access to the three long tables laden with cakes and pastries of all varieties. We each filled our plates with a little of this and a little of that. Clemens had slivers of at least five different kinds of cakes. Recalling what he chose from the buffet, I might report that:

    (3)   *He ate the most CHOCOLATE cake.*

What I mean when I say this is that, of all the cakes he sampled, he ate more chocolate cake than he did any other kind. This is an **internal relative reading**, so called because the focus of comparison is an element internal to the superlative NP.[2] This use of *most* appears to be degraded for some speakers,[3] it is facilitated by appropriate prosody, with rise-fall intonation on *most* and pitch accent on *chocolate*. It is distinct from the more familiar **external relative readings** in (2a,b), or in (4) below. Indeed, if (4) happens to be false (Füsun or I ate more than he did), (3) may still be true, because the amount of chocolate cake eaten by anyone other than the subject is irrelevant for (3).

    (4)   *CLEMENS ate the most chocolate cake.*

What is interesting about the internal relative readings is that they are only available for the superlatives of quantity (Q-) adjectives, *many, much, few* and *little*. Even for speakers who dislike (3) there is a strong contrast between their judgment of this type of reading for a Q-superlative and their outright rejection of the reading for the superlative of other gradable adjectives. The internal relative reading is not available at all for (5). What comes through instead is the absolute reading, and a sense that the accent on *chocolate* is misplaced.

    (5) *#He ate the tastiest/smallest CHOCOLATE cake.*

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[2] Internal relative readings can also arise from focusing a PP or the noun itself as in, *He ate the fewest desserts from the THIRD table* or *He ate the least STRUDEL.*

[3] I leave the problem of inter-speaker variation with respect to this construction to future research. In the meantime, the fact that the internal reading is possible for some speakers with Q-superlatives (but is never possible with non-Q superlatives) requires explanation, which is the goal of this paper.

Let us summarize the judgments. There is a contrast between Q-superlatives, which give rise to both internal (3) and external (4) relative readings, and non-Q-superlatives, which do not give rise to internal readings (5), but only to external readings (1b&c).

	Proportional/absolute	External relative	Internal relative
Q-superlatives (*most, fewest, least*)	✓	✓	✓
Non-Q-superlatives (*tastiest, smallest, etc.*)	✓	✓	✗

The contrast between Q-adjectives and non-Q-adjectives with respect to the internal relative reading is a problem for an analysis that treats *most* straightforwardly as a superlative adjective. On the movement approach that Hackl favors (Szabolcsi 1986, Heim 1999), the internal relative reading of Q-superlatives (3) and non-Q-superlatives (5) are predicted to be equally good. On Pancheva and Tomaszewicz's (2012) movement-and-*in-situ* account they are predicted to be equally bad. I demonstrate the problems of each approach in section 2. In section 3, I present an analysis of *the most* as a constituent – specifically, a measure phrase headed by a silent measure noun. In section 4, I show how this allows us to derive the NP-internal relative reading. In section 5, I discuss constraints on this measure pseudopartitive construction, which begin to explain why it is not a possible parse for superlatives of quality. Section 6 concludes.

2. The Problem of the NP-internal reading

2.1. The movement approach overgenerates

The movement approach is so called because it derives relative readings by covert movement of the superlative morpheme out of the definite-marked noun phrase. In its raised position, [est-C] takes as its external argument whatever individual is being compared – either the external argument of the verb, or some other constituent that has also covertly raised. As P&T show, a problem with this approach is that it overgenerates. The LF for (5), *He ate the tastiest chocolate cake*, is shown in (6). On this approach it is possible to derive the NP-internal relative reading for any adjective by first raising the superlative morpheme and then extracting the NP-internal constituent that is contrasted. This extraction is possible because the definite article is treated as vacuous (indicated in (6) by the strikethrough). The resulting truth conditions are given in (7).

(7) [chocolate]$_1$ 1 [est-C]$_2$ λdλP [he ate [~~the~~ d-tasty t_1 cake]

(8) ∃d[he ate d-tasty chocolate cake] ∧ ∀P∈C[P≠chocolate→¬[he ate d-tasty P cake.]]

> "There is some degree of tastiness of chocolate cake that he ate, and for no other relevant kind is it the case that he ate cake of that kind that reaches that degree of tastiness."

This is the internal relative reading. Since this reading is in fact not available for (5), this approach is not constrained enough. Following P&T, we turn therefore to the *in situ* approach.

2.2. The *in situ* approach

Heim (1999) applies Roothian focus semantics to superlative constructions to show how an external relative reading can be derived without extracting the superlative morpheme from a definite-marked noun phrase. This approach also requires some movement; the definite-marked DP must raise and adjoin to the clause in order for a covert focus operator (~) to scope over the appropriate constituent. Because this movement is obligatory, I assume that the definite-marked DP is forced to move by a type mismatch. Coppock and Beaver (2014) (henceforth C&B) argue that relative superlative DPs are definite but indeterminate, denoting an existential quantifier of type $\langle\langle e,t\rangle,t\rangle$[4]. The LF in (8) illustrates how the external relative reading is derived "*in situ*".

(8) [[the [est-C] d-tasty chocolate cake] ~S 1[[Clemens]$_F$ ate t$_1$]]]

The ~ operator introduces the presupposition that S consists of things that Clemens ate and things that were eaten by relevant alternative people. The comparison class argument, C, is valued by focus-association as the union of the set, S, introduced by the focus operator.

(9) $C\subseteq \cup S = \{x: \exists y\in\{$Clemens, Füsun, Emily$\}\wedge$ y ate x$\}$

(10) $\lambda x\exists d[$d-tasty-choc-cake$(x)] \wedge \forall y\in C[y\neq x \rightarrow\neg[$d-tasty-choc-cake$(y)]]$

This is the property of being (out of all the things that my friends and I ate) something that is chocolate whose degree of tastiness exceeds that of any other chocolate cake. Following C&B (although see footnote 4), the definite article introduces the (somewhat redundant) presupposition that the property in (10), if not empty, is a singleton set, and shifts it to a higher

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[4] Translating Coppock & Beaver's ∂ and EX into more familiar/compact terms, I take the definite article in relative superlative DPs to denote the definite/indeterminate function which is given in (11) below. In C&B this denotation results from the application of a partiality operator followed by a type shift. I leave the details aside here, but note that my execution of existential closure in (24) and elsewhere relies on a similar indefinite/indeterminate function which I identify with the silent D of bare plurals and mass nouns: $\lambda P.\lambda Q.\exists x[P(x)\wedge Q(x)]$. While I adopt Coppock & Beaver's ideas about definiteness, I continue to assume Heim's denotation for the superlative morpheme itself.

type. The superlative DP has the denotation in (12). From its raised position, this takes the ordinary value of the clause as its argument, creating the proposition in (13).

(11) $[\![the]\!] = \lambda P : |P| \leq 1. \lambda Q. \exists x[P(x) \wedge Q(x)]$

(12) $\lambda Q \exists x \exists d[d\text{-tasty-choc-cake}(x)] \wedge \forall y \in C [y \neq x \rightarrow \neg[d\text{-tasty-choc-cake}(y)]] \wedge Q(x)$

(14) $\exists x \exists d[d\text{-tasty-choc-cake}(x) \wedge \forall y \in C[y \neq x \rightarrow \neg[d\text{-tasty-choc-cake}(y)]] \wedge$ Clemens ate x]

This is the proposition that the unique entity that is the tastiest chocolate cake (out of all the things that my friends and I ate) was eaten by Clemens. As Sharvit and Stateva (2002) point out, an additional effect of focus on the subject is to assert the negation of the sentence with any other person as subject – it is *only* Clemens who ate the tastiest chocolate cake.

2.3. The *in situ* approach undergenerates

P&T observe that NP-internal relative readings are available in Slavic for superlatives of adjectives inside indefinite noun phrases. They apply the movement approach to derive internal relative readings in the absence of definite marking, but they argue that whenever an overt definite article introduces a DP, movement of the degree morpheme out of that constituent is barred. They assume that the external relative reading can be derived only by the *in situ* approach in these cases. And on this approach it is not possible to derive the internal reading, as we will see below. This is a desirable result, for non-Q-superlatives in English. We saw that the internal reading is unavailable for (5). But it is problematic for Q-superlatives, which do allow the internal reading when (and only when) the DP is introduced by the definite article, as in (3). Let us see why the *in situ* approach cannot generate the internal reading for our cake examples. Following the assumptions we adopted in the previous section, the superlative DP (bracketed in (14)) is existentially quantified and must QR. This gives rise to the LF in (15).

(14) He ate [the tastiest/most CHOCOLATE cake].

(15) [$(\sim S)_A$ [the [est-C] $(\sim S)_B$ 1 [d_1-tasty/much [chocolate]$_F$ cake]] 2 He ate t_2]

For focus association to succeed, the ~ operator must scope over the focused constituent, but it must also be discontinuous with C. If the operator is inserted in a high position $(\sim S)_A$, then the derivation will crash because it contains a loop of infinite regress. The identity of the alternative set, S, depends on the focus value of a constituent that contains C. But the value of C depends on

the identity of S. Inserting it in a lower position (~S)ᵦ creates different problems. Here, the focus operator's requirement for alternatives conflicts with the presupposition of [est]. The superlative morpheme requires that everything in the comparison class belong to the set denoted by its sister node, i.e. the set of degrees of tastiness of chocolate cake. But the operator requires that degrees of tastiness of at least one alternative to chocolate cake be included in that set.

Assuming, with P&T, that definite-marked DPs are islands for degree-extraction makes it possible to explain why internal relative readings are unavailable for non-Q-superlatives. Only external relative readings are available because only these can be derived using the *in situ* approach. But this approach undergenerates, predicting that (3) should be as bad as (5).

In the next section, we will see that there is reason to believe that the syntax of Q-superlatives is different from that of other superlatives. The measure pseudopartitive structure that I will argue *the most* (and other Q-superlative phrases) are merged in, makes it possible to generate the internal relative reading for them using the *in situ* approach. We can have *the most chocolate cake*, and rule out *the tastiest*, too.

3. *The most* as a measure phrase

Schwarzschild (2006) notes that Q-adjectives have semantic properties in common with the measure phrases that appear in pseudopartitive constructions. Indeed, he suggests that they are also merged in a pseudopartitive structure. I will begin by proposing a simple implementation of Schwarzschild's ideas, based on what I consider the null hypothesis, that measure phrases are full DPs of type *e* or $\langle\langle e,t\rangle,t\rangle$. I will then argue for an expansion of his typology of measure phrases and suggest how this can apply to Q-adjectives and Q-superlatives.

3.1. The MonP projection

Schwarzschild observes that there are two sub-types of measure phrases that can modify nouns. Attributive measure phrases (bolded in the examples in (16)) consist of a number and a bare measure noun representing some type of unit. They can modify mass nouns or singular/plural count nouns. The other type of measure phrase appears in pseudopartitive measure constructions, as in (17). They consist of a weak quantifier, and a measure noun that is inflected for number.

(16) a. She used **one-inch** plywood.
　　 b. He ate a **500-calorie** cookie.
　　 c. I bought some **three-pound** lobsters.

(17) a. She used **a square foot** of plywood.
　　 b. He ate **several handfuls** of nuts.
　　 c. I bought **three pounds** of lobster(s).

The measure phrases that appear in pseudopartitive constructions seem to have a larger syntactic structure than attributive measure phrases. Taken at face value, this type of measure phrase is

simply an indefinite DP. Attributive measure phrases intersectively modify the substance nouns that follow them. *One-inch plywood* describes a substance that is uniformly both plywood and one inch (thick). Pseudopartitive measure phrases have a slightly different mode of modification. *A square foot of plywood* describes something which is plywood and which occupies an area of a square foot. This modification is mediated by a functional element pronounced *of*. Schwarzschild labels this functional head Mon^0 and proposes that it introduces the measure phrase as an additional thematic argument of the noun.

(18) [$_{MonP}$ [$_{MeasP}$ a square foot] [$_{Mon'}$ [of$_{Mon}$] [$_{NP}$ plywood]]]

It is often assumed that measure nouns and measure phrases belong to different types than common nouns and NPs, although there is much debate as to what those types are. Kennedy (2001) treats measure phrases as instances of *d*. Champollion (2010) considers measure nouns to be functions from numbers to intervals (type $\langle n, \langle d,t \rangle \rangle$) and full measure phrases to denote intervals. Schwarzschild (2006) refers to measure phrases as predicates of intervals. I am going to pursue the null hypothesis, which is that all nouns are of type $\langle e,t \rangle$ and all DPs either type *e* or type $\langle \langle e,t \rangle, t \rangle$. For example, *square foot* denotes the set of objects that are one square foot in area. Importantly, the dimension AREA is a part of the semantic information that this lexical item brings with it. Two portions of matter that are each a square foot cannot be counted as separate individuals in the domain of *square foot* if they overlap in area.

(19) a. ⟦square foot⟧ $= \lambda y.\text{square-foot}'_{AREA}(y)$

b. ⟦a square foot⟧ $= \lambda P \exists y.\text{square-foot}'_{AREA}(y) \wedge P(y)$

How does Mon^0 relate this new argument to the NP, which is a property of individuals? It does so by introducing the additional predication that this argument is **coextensive** with the external argument of the substance noun along a particular dimension. Two individuals are coextensive if each is a material part of the other. Let us assume, as does Schwarzschild, that Mon^0 is parameterized for a particular dimension (indicated by subscript). The equals sign in its denotation is also subscripted to remind us that it stands for "is coextensive" on that dimension.

(20) ⟦Mon⟧$_{DIM} = \lambda P \lambda y \lambda x. P(x) \wedge y =_{DIM} x$

Let me illustrate how we should understand MonP to compose in sentence (17a). Initially, the measure phrase *a square foot* merges in the specifier of MonP, as shown in (21). But since the measure phrase is an indefinite DP, it has to QR, leaving behind a trace that saturates Mon^0's

external argument. MonP itself must merge with a D head to form a DP (22). I will assume it is the silent indefinite D of bare plurals and mass nouns.

(21) [$_{MonP}$ [$_{MeasDP}$ D= *a* [$_{MeasNP}$ *square foot*]] Mon^0=*of* [$_{NP}$ *plywood*]]

(22) [$_{DP}$ D=$\varnothing_{SOME}$ t [$_{Mon'}$ *of plywood*]

The LF of the sentence with all indefinites QRed is given in (23), followed by the derivation.

(23) [$_{MeasDP}$ *a square foot*]$_1$ 1 [$_{IP2}$ [$_{DP}$ $\varnothing_{SOME}$ [$_{MonP}$ t$_1$ Mon'=*of plywood*]]$_2$ 2 [$_{IP1}$ *Anne used* t$_2$]]

(24) $[\![Mon]\!]_{AREA} = \lambda P \lambda y \lambda x. P(x) \wedge y =_{AREA} x$

$[\![Mon']\!]_{AREA} = \lambda x.[plywood'(x) \wedge x =_{AREA} t_2]$

$[\![DP]\!] = \lambda Q \exists x.[plywood'(x) \wedge x =_{AREA} t_2 \wedge Q(x)]$

$[\![IP_1]\!] = \lambda x.[used (x)(a)]$

$[\![DP]\!]([\![IP_1]\!]) = \exists x.[plywood'(x) \wedge x =_{AREA} t_2 \wedge used'(x)(a)]$

$[\![IP_2]\!] = \lambda y \exists x.[plywood'(x) \wedge x =_{AREA} y \wedge used'(x)(a)]$

$[\![MeasDP]\!] = \lambda P \exists y.square\text{-}foot'_{AREA}(y) \wedge P(y)$

$[\![MeasDP]\!]([\![IP_2]\!]) = \exists y \exists x.square\text{-}foot'_{AREA}(y) \wedge [plywood'(x) \wedge x =_{AREA} y \wedge used'(x)(a)]$
  "There is a sq. foot, and it is coextensive with something Anne used that is plywood"

3.2. Adjectivally modified measure phrases

Though Schwarzschild does not discuss these cases, it seems possible to extend his typology to include measure phrases that contain adjectival modification of the measure noun. Examples are given in (25a-c). The *it*-clefted versions in (d-f) verify that the bolded strings are in fact constituents.

(25) a. She used **a *generous* amount** of plywood.
    b. He ate **several *small* handfuls** of Brazil nuts.
    c. I bought **an *expensive* quantity** of lobsters.
    d. It was a generous amount that she used of plywood.
    e. It was several small handfuls that he ate of Brazil nuts.
    f. It was an expensive quantity that I bought of lobsters.

Importantly, in each of the sentences in (25), the adjective serves to specify the size of the unit somehow. Even *expensive* is understood to be a quality that reflects size, since the expense of something purchased at a 'per pound' rate is in direct proportion to its quantity. If these adjectives are replaced by different ones that specify properties of the substance instead of the measurement, the results are a little odd. They become much worse when we try to move the bolded strings as in the *it*-cleft construction:

(26) a. ?She used **a smooth amount** of plywood.
      b. ?He ate **several crunchy handfuls** of Brazil nuts.
      c. ?I bought **a delicious quantity** of lobsters.
      d. *It was a smooth amount that she used of plywood.
      e. *It was several crunchy handfuls that he ate of Brazil nuts.
      f. *It was a delicious quantity that I bought of lobsters.

What (26d-e) shows us is that the sentences in (26a-c) are only acceptable if the objects are parsed as in (27). The constituent that the adjective modifies must contain the substance noun:

(27) a. a **smooth** [amount of plywood]
      b. several **crunchy** [handfuls of Brazil nuts]
      c. a **delicious** [quantity of lobsters]

Whatever the relationship is between the pairs of nouns in (27), these are not true measure pseudopartitive constructions. We can see that the article, if present, does not form a sub-constituent with the measure noun, and we may assume that *of* is not the spell out of Mon^0.

But we have admitted some adjectives into the measure pseudopartitive structure, so we can consider the possibility that superlative forms of those adjectives are admissible as well. Szabolcsi (1986) was one of the first to observe that, unlike other definite-marked DPs, those containing superlatives pass the diagnostics for weakly quantified DPs. One diagnostic is illustrated in (28), where the object of inalienable possession cannot be a strongly quantified DP, but definite-marked superlative DPs are acceptable.

(28) a. *Clemens has **the** small appetite.
      b. *Clemens has **all** children.
      c. Clemens has **the** small**est** appetite/**the** few**est** children.

Since measure phrases in the pseudopartitive can include weak quantifiers, it is to be expected that once adjectives are admitted to the structure, superlative marking and the definite article that comes with it should be possible as well. We predict that the superlative versions of (25) will be acceptable. This seems to be the case (29a-c), but there is a problem with the *it*-clefts (29d-f):

(29)   a. She used **the most generous amount** of plywood.
       b. He ate **the smallest handfuls** of Brazil nuts.
       c. I bought **the most expensive quantity** of lobsters.
       d. ??It was the most generous amount that she used of plywood.
       e. ??It was the smallest handfuls that he ate of Brazil nuts.
       f. ??It was the most expensive quantity that I bought of lobsters.

I submit that the failure of clefting here is due to information structure rather than non-constituency of the bolded phrases. It makes sense that a relative superlative DP should fail to denote inside of an *it*-cleft, where it receives focus. As we saw in section 2, it is necessary for focus to be assigned to some constituent external to the superlative-marked DP in order for a covert focus operator to be merged. Topicalization, as in (30), is a more appropriate constituency test because it has the right kind of information structure. The following sentences confirm the constituency of the definite-marked superlative measure DPs in (29a-c).

(30) a. The most generous amount, she used of plywood.
     b. The smallest handfuls, he ate of Brazil nuts.
     c. The most expensive quantity, I bought of lobsters.

Not only are the sentences in (30) felicitous, they lend themselves to a reading where the substance noun, or a lower modifier thereof, receives focus. (30a) could mean that the person in question used a more generous amount of plywood than of any other material. Pitch accent on *Brazil* in (30b) gives it a similar ring to the chocolate cake example (3) in the *Kuchenbuffet* scenario. Considering *The smallest handfuls of Brazil nuts* as the extended substance NP, we could call this an NP-internal relative reading of the superlative, since *Brazil* is internal to this larger constituent. What makes it possible is the fact that *smallest* is not directly modifying *Brazil nuts*. Instead, it is modifying the measure noun, *handfuls*.

What I want to suggest is that the internal relative reading of quantity superlatives is based on the same structure, but with a silent measure noun. Let us take a closer look at the pseudopartitive structure and how it applies to Q-adjectives in order to understand this hypothesis.

3.3. Q-adjectives in the pseudopartitive structure.

Schwarzschild describes the semantic difference between Q-adjectives and other gradable adjectives as analogous to the difference between the measure phrases in pseudopartitive measure constructions and attributive measure phrases. The examples from (16) and (17) are repeated in (31) and (32) with their adjectival counterparts.

(31) a. She used **one-inch** plywood.   d. She used **thick** plywood.
     b. He ate a **500-calorie** cookie.   e. He ate a **fattening** cookie.
     c. I bought some **three-pound** lobsters.   f. I bought some **huge** lobsters.

(32) a. She used **a square foot** of plywood.   d. She used **a little** plywood.
     b. He ate **a few handfuls** of nuts.   e. He ate **so few** nuts.
     c. I bought **three pounds** of lobster(s).   f. I bought **that much/many** lobster(s).

The property that the examples in (32) are claimed to have, that those in (31) lack, is identified as 'monotonicity' by Schwarzschild (hence the 'Mon' label for the functional projection that encodes it). Schwarzschild assumes that Mon^0 is also present in sentences like (32d-f), but that it is licensed to be silent whenever it hosts a Q-adjective in its specifier. The measure pseudopartitive structure for (32a) is given in (33a). The parallel, covert pseudopartitive structure for (32d) is given in (33b).

(33) a. [$_{MonP}$ [$_{MeasP}$ a square foot] [$_{Mon'}$ [of$_{Mon}$] [$_{NP}$ plywood]]]

     b. [$_{MonP}$ [$_{Q-AP}$ a little] [$_{Mon'}$ [$\varnothing_{Mon}$] [$_{NP}$ plywood]]]

I adopt Schwarzschild's syntax for the extended projection of the substance noun but postpone my discussion of the semantics of this construction to section 5. In order to introduce the Q-adjective phrase with the same Mon^0 that introduces DP measure phrases of type $\langle\langle e,t\rangle,t\rangle$, we need to assume that it is of that type. A similar syntactic move is made by Kayne (2007), who proposes that Q-adjectives combine with contain a silent noun, NUMBER or AMOUNT.[5]

One piece of syntactic evidence that we are on the right track is that, unlike other types of adjectives, Q-adjectives can appear in argument positions in English without modifying any overt nominal (34a,c). Conversely, they may not combine with the NP pronoun *one*(*s*) (34e).

(34) a. Anne bought many.   c. Anne bought too much.   e. *Anne bought many ones.
     b. *Anne bought big.   d. *Anne bought too big.   f. Anne bought big ones.

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[5] Pancheva (2015) also makes use of the silent noun idea in her explanation of the difference between Bulgarian and English with respect to the proportional reading of *most*. I believe that my proposal for definite *the most* as a measure phrase is not incompatible with Pancheva's for bare *most*, but this possibility requires further investigation.

This indicates that the Q-adjectives may have already merged with some silent nominal element. If we incorporate this null element into the MonP structure, we end up with a constituent that looks more like an ordinary measure phrase. Indeed, the mysterious indefinite article that appears with *few* and *little* can be analyzed straightforwardly as the weak quantifier of a measure DP.

(35) [$_{MonP}$ [$_{MeasDP}$ a [d-little] N$_{AREA}$] [$_{Mon'}$ [∅$_{Mon}$] [$_{NP}$ plywood]]]

An overt measure noun supplies the dimension feature of the measure phrase and provides a kind of sortal for counting – we know that when counting *square feet*, for example, two portions of matter that are each a square foot do not count as distinct individuals if they overlap in area. The silent noun in (35) serves the same function: restricting the dimension and referring to a portion of matter that does not overlap with any other portion on that dimension. An alternative approach might encode these elements in the Q-adjective itself. But we will use the silent, dimensionally-specified noun for concreteness. Separating out the nominal element allows us to use the following simple denotations for *much* and *little*:

(36) a. ⟦much⟧$_{DIM}$ = λdλx.μ$_{DIM}$ ≥d   b. ⟦little⟧$_{DIM}$ = λdλx.μ$_{DIM}$ ≤d

We can treat *many* and *few* as equivalent to these except that they are specified for the count dimension. The Q-adjective is merged with overt or covert degree morphology in a DegP which in turn is merged with the silent N. From these assumptions it is a short step to (37) in which the superlative form of *much* is used in a MonP structure:

(37) [$_{MonP}$ [$_{MeasDP}$ the [est-C] [d-much] N$_{AREA}$] [$_{Mon'}$ [∅$_{Mon}$] [$_{NP}$ plywood]]]

The agreement morphology of Flemish provides some interesting evidence for such a structure. Roelandt (2014) argues for a DP-within-DP analysis of *het meeste NP* ('the most NP'), based on a mismatch between the features of the determiner and of the overt noun. I turn to this next.

3.4. Agreement mismatch in Flemish

According to Roelandt (2014) Flemish Dutch has an internal relative reading of *het meeste* ('the most'). The reading is available with a peculiar form, in which the definite article does not agree with the noun in number and gender. The following examples illustrate two points. First, Flemish patterns with English in that the internal relative reading (38a) is not available with non-Q

superlative adjectives, while the external relative and absolute readings are (38b&c). Second, Flemish requires *phi*-feature agreement between the article and the noun it introduces (39).

(38) *Jan heeft de   beste platen   van Zappa.*   (Flemish, Koen
 Jan has   the_{pl.fem}   best   record_{pl.fem} by Zappa   Roelandt, p.c.)
 a. #"John has better albums by Zappa than by anyone else"
 b. "John has better albums by Zappa than anyone else does"
 c. "John has the best albums by Zappa that exist"

(39) **Jan heeft het   beste platen   van Zappa.*   (Flemish)
  Jan has   the_{sing.neut} best   record_{pl.fem} by Zappa

When the superlative is a Q-adjective, however, it is possible for the determiner to appear in the singular neuter form in the same DP as a plural noun (40). In this construction the NP-internal reading is available (40a). Agreement is also possible (41), but the internal reading is lost (41a).

(40) *Jan heeft* [*het   meeste platen   van Zappa*].   (Flemish)
 Jan has   the_{sing.neut} most   record_{pl.fem} by Zappa
 a. "John has more records by Zappa than by any other band."
 b. "John has more records by Zappa than anyone else does."

(41) *Jan heeft* [*de   meeste platen   van Zappa*].   (Flemish)
 Jan has   the_{pl.fem} most record_{pl.fem} by Zappa
 a. #"John has more records by Zappa than by any other band."
 b. "John has more records by Zappa than anyone else does."

Roelandt argues that the neuter singular features on the determiner show default agreement with a null noun. This suggests to him that [*het meeste* N$_\varnothing$] is a DP constituent in a specifier of the overt noun's extended projection. Roelandt's proposal fits well with what we have concluded about *the most* as a measure phrase. The agreement morphology in Flemish makes it transparent that *het* is not merged directly with the overt noun in (40), thus making indirectly visible the silent measure noun with which it forms a constituent. His data and analysis lend support to the idea that this structure is available to Universal Grammar, and is even made use of in Germanic.

4. Deriving *the most* internal reading

Returning to our original example (*He ate the most CHOCOLATE cake*) we can now see what this alternative syntax for Q-superlatives achieves. As a measure phrase with a silent measure noun, *the most* N$_\varnothing$ is initially merged in the specifier of MonP:

(42)
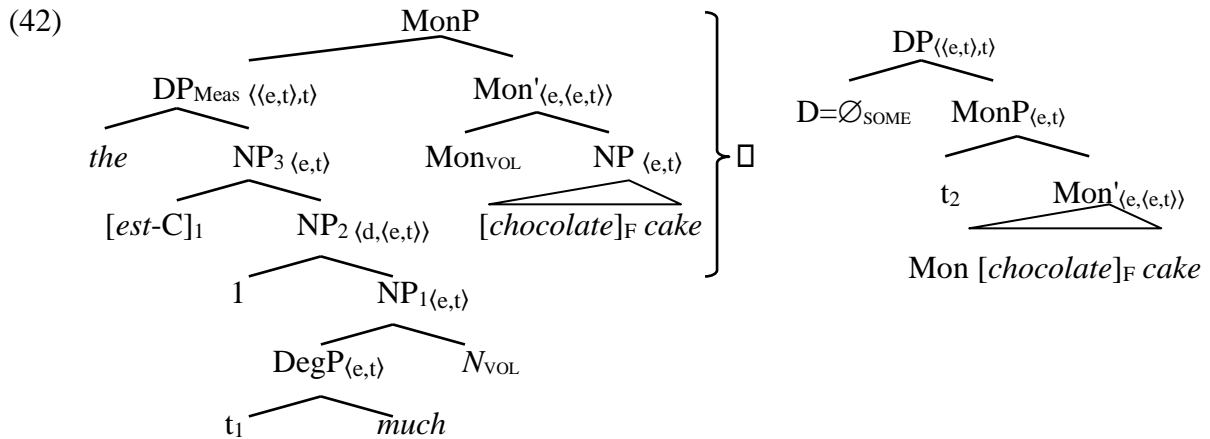
As with the derivation in section 3.1, there is a type mismatch between the Measure DP and Mon'. The measure phrase must QR, leaving a trace to saturate Mon'. MonP then merges with silent indefinite D as indicated in (42). Intuitively, MonP is the property of being *chocolate cake* that is coextensive with the entity described by the measure DP, but in order to determine what the measure DP denotes, the comparison class argument, C, must be valued.

Recall that the problem with the attributive modification structure was that there was no possible place for a focus operator to be inserted above the NP-internal focused element where it would also be discontinuous with C. Focus association failed either due to infinite regress or a clash between the requirements of the focus operator and the presuppositions of the superlative morpheme. This is no longer an issue in (43). The operator can be merged just above IP_5 where the trace of the measure DP is bound. C and ~S are discontinuous, and the operator has the substance DP containing the focus-marked *chocolate* in its scope.

(43)
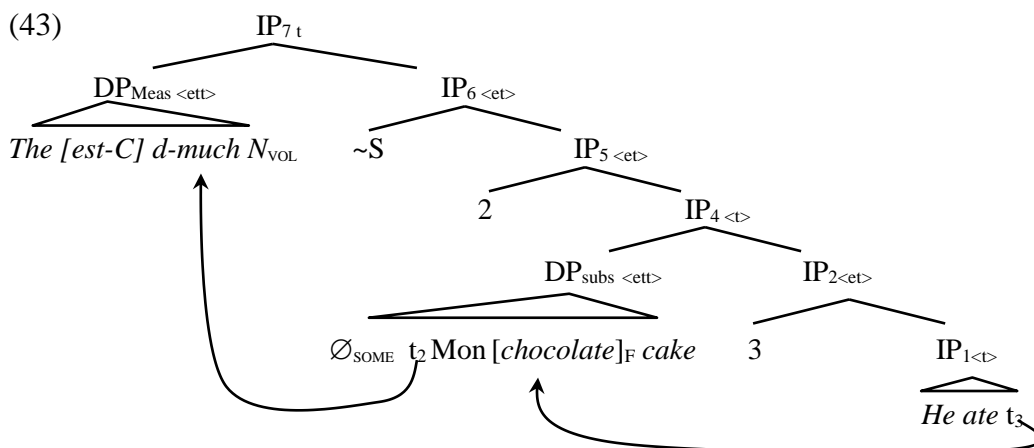
C is valued by association with the alternative set introduced by this operator. S contains sets of things that are coextensive with chocolate cake that Clemens ("he") ate or some alternative to

chocolate cake that he ate (44). So C is a subset of the grand union of this.

(44)
$$S \subseteq [\![IP_5]\!]_F = \begin{cases} \lambda x \exists y.[ate(y)(c) \wedge \mathbf{chocolate}(y) \wedge cake'(y) \wedge x=_{VOL}y] \\ \lambda x \exists y.[ate(y)(c) \wedge \mathbf{almond}(y) \wedge cake'(y) \wedge x=_{VOL}y] \\ \lambda x \exists y.[ate(y)(c) \wedge \mathbf{vanilla}(y) \wedge cake'(y) \wedge x=_{VOL}y]... \end{cases}$$

(45) $C = \cup S = \{x : \exists Q \in \{chocolate, almond, vanilla...\} \exists y.[ate(y)(c) \wedge Q(y) \wedge cake(y) \wedge x=_{VOL}y\}$

With the value of the comparison class established, we can see that the superlative NP_3 (in (42)) is the property of being the unique thing (out of those things that are coextensive with some flavor of cake that Clemens ate) that reaches the greatest degree of volume:

(46) $[\![NP_3]\!] = \lambda x \exists d.[N_{VOL}(x) \wedge \mu_{VOL}(x) \geq d] \wedge \forall y \in C[y \neq x \rightarrow \neg[N_{VOL}(y) \wedge \mu_{VOL}(y) \geq d]]$

This combines with the definite article to produce an existentially quantified DP as in (47). The ordinary value of IP_6 is equal to that of IP_5 (provided that the presuppositions of ~ are satisfied, that is, that S is a subset of the alternative denotation of IP_5. The derivation proceeds as in (48).

(47) $[\![DP_{Meas}]\!] = \lambda Q \exists x \exists d.[N_{VOL}(x) \wedge \mu_{VOL}(x) \geq d] \wedge \forall y \in C[y \neq x \rightarrow \neg[N_{VOL}(y) \wedge \mu_{VOL}(y) \geq d]] \wedge Q(x)$

(48) $[\![IP_6]\!]^o = \lambda x \exists y.[ate(y)(c) \wedge chocolate(y) \wedge cake(y) \wedge x=_{VOL}y]$

$[\![IP_7]\!] = \exists x \exists d.[N_{VOL}(x) \wedge \mu_{VOL}(x) \geq d] \wedge \forall y \in C[y \neq x \rightarrow \neg[N_{VOL}(y) \wedge \mu_{VOL}(y) \geq d]]$

$\wedge \exists y.[ate(y)(c) \wedge chocolate(y) \wedge cake(y) \wedge x=_{VOL}y]$

"There is something which is the largest volume out of all the flavors of cake that Clemens ate and there is something that is chocolate cake that he ate, and these are coextensive on the volume dimension."

This will be true just in case Clemens ate a greater volume of chocolate cake than he did of any other kind of cake. This successfully derives the NP-internal truth conditions.

5. Semantic constraints on the construction

If this is indeed the correct derivation for the internal relative reading of *the most*, then a pressing question remains. Why is it not possible for superlatives of non-quantificational adjectives to be

parsed with this structure, giving rise to the internal relative reading in the same way as Q-superlatives? For example, why is the following structure not available as a parse for the superlative NP in (5) (*He ate the tastiest chocolate cake*)?

(49) $[_\text{MonP} [_\text{MeasP}$ the tastiest $N_\varnothing$] $[_\text{Mon'} [\varnothing_\text{Mon}] [_\text{NP} [\text{chocolate}]_F$ cake]]]

Recall that in (34) above, non-Q-adjectives must appear with an overt pronoun. Whatever causes (34b,d) to be ungrammatical could be assumed to prevent the parse in (49). But it would be more satisfying to find an explanation for this in the semantics of the construction. In this section I pursue an answer that uses Champollion's notion of Stratified Reference.

5.1. Stratified Reference

Champollion (2010, 2015a,b) formalizes the semantic restriction on measure pseudopartitives as a higher-order property of Stratified Reference (SR). There is a presupposition that the substance noun (P) and its external argument (x) must satisfy this property, which is defined as follows:

(50) $SR_\mu(P,x)$ iff $x \in {}^*\lambda y[P(y) \wedge \mu(y) < \mu(x)]$

        A property, P, has stratified reference for a measure function with respect to a particular argument, x, just in case x can be exhaustively divided into parts that each have the property themselves and that each measure strictly less than the whole.

While the expression of measurements in terms of particular units may vary, the measure function for a particular dimension will always return the same abstract degree for a given entity. Therefore, in integrating this presupposition into our denotation of Mon^0 we can simply match the measure function to the dimension that Mon^0 itself is parameterized for.

(51) $[\![\text{Mon}]\!]_\text{DIM} = \lambda P \lambda y \lambda x: SR_{\mu\text{DIM}}(P,x). P(x) \wedge x =_\text{DIM} y$

Recall that we characterized a measure noun as a property of type $\langle e,t \rangle$ that specifies a dimension as part of its lexical entry. *Square foot* encodes AREA, *degree Fahrenheit,* TEMPERATURE. Since the noun is the lexical head of the measure phrase, we can assume that this dimension feature is visible to the Mon^0 head that introduces the measure phrase to the substance NP. Mon^0 selects a measure phrase that matches the dimension for which it is parameterized.

5.2. Ruling out *the tastiest*

In section 3.2 we argued that a measure phrase can include adjectival modification *as long as* the adjective serves to further specify the size of the unit denoted by the measure noun. If a lexical adjective were to modify a silent measure noun, we would be able to tell from the dimension denoted by the adjective what dimension feature the noun encodes.

This information, combined with what we know about the presupposition introduced by Mon^0 allows us to rule out the hypothetical structure in (49) as a parse for *the tastiest chocolate cake* (repeated here but with the tastiness dimension indicated on the silent measure noun).

(52) * $[_{MonP} [_{MeasP}$ the tastiest $N_{TASTE}]$ $[_{Mon'} [\varnothing_{Mon}]$ $[_{NP} [chocolate]_F$ cake$]]]$

In order for Mon^0 to introduce this measure phrase, it must be parameterized for the 'tastiness' dimension. This Mon^0 would introduce the presupposition that *chocolate cake* be exhaustively divisible into parts such that each part has a strictly lower tastiness measure than the whole. This is not the case for chocolate cake, so the MonP structure is undefined. A Mon^0 parameterized for some other dimension, (for example, volume), for which *chocolate cake* does have stratified reference, would not be able to introduce a measure phrase modified by *tasty*. (52) is therefore not a possible parse for the string – it can only compose with *tastiest* as an attributive modifier:

(53) $[_{DP}$ the $[_{NP}$ tastiest $[_{NP} [chocolate]_F$ cake$]]]$

With the focused element, *chocolate* trapped inside the same definite-marked DP as the superlative morpheme, there is no way to derive the internal relative reading.

5.3. Ruling out superlatives of size

A more difficult challenge to my proposal is posed by those adjectives that more readily appear as modifiers of overt measure nouns. We saw that *small* can modify *handful* and *generous* can modify *amount* in the pseudopartitive. Why, then, can't these appear with a silent N_{VOL} or $N_\#$? For example, we expect (54) to give rise to an NP-internal relative reading, if it can be parsed as containing the MonP structure in (55).

(54) He ate the smallest ALMOND tarts.

(55) $[_{MonP} [_{MeasP}$ the smallest $N_{VOL}]$ $[_{Mon'} [\varnothing_{Mon}]$ $[_{NP} [almond]_F$ tarts$]]]$

Nothing in the semantics of the construction as we have understood it should bar *the smallest* from appearing as a constituent in this context. The sentence should compose just as (3) did. It would not express a proposition about the size of the individual tarts, instead it would assert that that the *volume* of almond tarts that Clemens ate was smaller than the volume he ate of any other kind of tarts. Since size adjectives are not barred from this construction by the semantic requirements of stratified reference, we are forced, for the moment, to resort to the stipulation that this silent measure noun selects for Q-adjectives exclusively.

6. Conclusion

This paper has attempted to fill a gap in the literature on superlatives in English. We observed that definite-marked constructions with adnominal Q-superlatives give rise to both NP-external and NP-internal relative readings, while non-quantificational superlatives do not allow the internal readings. While it is advantageous to treat *most, least,* and *fewest* as superlatives of adjectival *many, little* and *few*, straightforward attempts to combine the syntax and semantics of Q-adjectives with either the movement or the *in situ* theory of superlatives make the wrong predictions about which readings should be available. Taking Schwarzschild's parallel between Q-adjective phrases and measure phrases perhaps more literally than he intended, we have arrived at a way to derive the internal reading for Q-superlatives. We hope that this line of inquiry will ultimately yield a more thorough explanation of the silent elements in this construction, their semantics and selectional requirements.

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An Experimental Investigation of Epistemic Modal Adverbs and Adjectives[1]

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Abstract. This paper analyses epistemic modal adverbs and adjectives, both theoretically and experimentally, while addressing the prevalent conceptions of modality and context update. While modality is standardly viewed and represented uniformly, we show that epistemic modal adverbs and adjectives differ in various linguistic environments, and present experimental evidence that supports the claim that epistemic modal adverbs and adjectives differ in terms of cognitive processing. While context update is standardly viewed as a two-stage process composed of assertion and acceptance/rejection, we present experimental evidence that supports the claim that there is also a stage of evaluation, in which the hearer considers the content of the assertion and the implications of adding this content to the common ground.

Keywords: semantics, psycholinguistics, epistemic modality, modal adverbs, modal adjectives, context update

1. Introduction

This paper utilizes the differences between epistemic modal adverbs and adjectives as a means for an experimental investigation that sheds light on epistemic modals in general and their context update properties.

The prevalent conception of modality, following the work of Angelika Kratzer (inter alia 1981; 1991; 2012) is that all modals should be given a uniform account, as truth-conditional quantifiers over possible worlds. Possibility modals are existential quantifiers and necessity modals are universal. The domain of quantification is determined by conversational backgrounds, which are function from worlds to sets of propositions.

The prevalent conception of assertion and the context update process that follows this speech act, following the work of Robert Stalnaker (1978) is that there are two basic stages – the first in which the speaker performs the assertion and the second in which the hearer either accepts or rejects the assertion. Acceptance leads to context update of the asserted proposition, i.e. the proposition is added to the common ground and an intersection operation is applied to the context set, thereby reducing the set of worlds constituting it (for more details, see Stalnaker 1978).

However, these theories, as they stand, treat modal adjectives and adverbs in the same way, which, as we will see, is not the case. We present a theory that minimally revises the prevalent view so as to account for these differences, and test our theory experimentally.

The paper proceeds as follows: **section 2** presents data showing that epistemic modal adverbs and adjectives behave differently in various linguistic environments. **Section 3** presents the theoretical basis of this paper, based on Wolf (2015a) (an early version of which appears in Wolf and Cohen 2009), which accounts for these differences and lays the foundation for the experiment in **section 4. Section 5** concludes the paper.

2.   The differences between epistemic modal adverbs and adjectives

Epistemic modal adverbs e.g. *possibly, probably* and *certainly* have the parallel epistemic modal adjectives *possible, probable,* and *certain*[2]. This parallel is apparent when viewing minimal sentences containing epistemic modal adverbs and adjectives:

(1) a. The dog is possibly on the lawn.

b. It's possible that the dog is on the lawn.

The immediate impression is that both sentences are variants of each other, both conveying the same degree of possibility. And indeed, the early literature by and large does not distinguish between modal adverbs and modal adjectives (inter alia Jackendoff 1972; Jacobson 1978; Perkins 1983) However, it has become increasingly clear (cf. Bellert 1977; Nilsen 2004; Piñón 2006; Piñón 2009; Ernst 2009) that the story is not that simple.

We begin with the first and most recognizable feature of epistemic modal adverbs that distinguishes them from epistemic modal adjectives which is their *Speaker Orientedness* (cf. Jackendoff 1972). Utterances containing modal adverbs convey that the person whose judgment is reflected by these adverbs is the speaker. This feature does not standardly manifest in utterances containing modal adjectives, as can be seen in the following example (based on a similar example from Nuyts 2001:71):

(2) A: It is probable that the stock market will crash.
   B: Whose opinion is this?

(3) A: The stock market will probably crash.
   B: #Whose opinion is this?

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[2] While non-epistemic interpretations of modal adjectives exist, this paper does not deal with them.

While the question in (2) is quite natural, i.e. the hearer wants to know whose judgment is conveyed by the speaker's assertion (while it may be the speaker's, it doesn't have to be), the question in (3) doesn't sound quite right. This is due to the intuition that in the modal adverb case it is clearly the speaker's judgment.

Another distinguishing element of epistemic modal adverbs and adjectives is behavior under various embeddings. Modal adjectives are easily embedded under negation while modal adverbs are difficult (Bellert 1977)[3]:

(4)   a.   { It's impossible/not possible that
               It's improbable/not probable that   } ,John has/will come.
               It's uncertain/not certain that

      b.   { #Impossibly/Not possibly
               #Improbably/Not probably   } ,John has/will come.
               #Uncertainly/Not certainly

Modal adjectives but not modal adverbs, are easily embedded under questions (Bellert 1977):

(5)   a. Is it possible/probable/certain that John has/will come?

      b. #Has/Will John possibly/probably/certainly come?[4]

Modal adjectives but not modal adverbs are good in the antecedent of conditionals (Piñón 2006):

(6)   a. If it is possible/probable/certain that the socialists will win the elections, the rich will worry about a luxury tax.

      b. #If the socialists possibly/probably/certainly win the elections, the rich will worry about a luxury tax.

Modal adjectives but not modal adverbs are easily embedded under factives (based on Papafragou (2006) concerning 'objective/subjective' epistemic modal auxiliaries):

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[3] Bellert also uses the pair *evident/evidently*. This is replaced by *certain/certainly* here, in order to keep the evidential component away.

[4] Stressing the modal adverb in these examples results in higher acceptability due to focus. We do not deal with the effects of focus on modal adverbs here, but see Döring (2012).

(7)   a. It is surprising that it is possible/probable/certain the socialists will win the elections.

      b. #It is surprising that the socialists will possibly/probably/certainly win the elections.

Agreements and disagreement about utterances containing modal adjectives target the entire utterance, including the modal. Agreements and disagreement about utterances containing modal adjectives target the prejacent, precluding the modal (based on Papafragou's 2006 *assent-dissent* diagnostic, concerning 'objective/subjective' epistemic modal auxiliaries):

(8)   A: It's possible/probable/certain that John is at home.
      B: That's not true/I agree.
      = It's not true/The hearer agrees that it's possible/probable/certain John is at home.
      ≠ It's not true/The hearer agrees that John is at home.

(9)   A: John is possibly/probably/certainly at home.
      B: That's not true/I agree.
      ≠ It's not true/The hearer agrees that John is possibly/probably/certainly at home.
      = It's not true/The hearer agrees that John *is* at home.

Another conversational diagnostic is the *reason to assert* test (Wolf 2015a):

(10) Scenario: A reality show in which 15 participants are competing for the role of 'Israel' next top barista'. One of the participants got voted out, leaving 14.

      Option A:
      Spectator 1: It's possible that Danny will be Israel's next top barista.
      Spectator 2: Why do you say that?
      Spectator 1: Well, Dina was just voted out.

      Option B:
      Spectator 1: Danny will possibly be Israel's next top barista.
      Spectator 2: Why do you say that?
      Spectator 1: ??Well, Dinna was just voted out.

It seems that the fact that one participant was voted out is in itself not reason enough to assert the modal adverb possibility claim, which is puzzling if modal adverbs convey possibilities and nothing else. The last data item is the following contrast, from Nilsen (2004):

(11) It's possible that Le Pen will win even though he certainly won't.
(12) #Le Pen will possibly win even though he certainly won't.

This item, termed *Nilsen's contrast* in Piñón (2006) will receive a special treatment in the next section, as it is the basis of this paper's experiment. The initial motivation for this contrast is to show that there are differences between epistemic modal adverbs and adjectives, hence that they

should receive a different treatment. And there is an agreement among theories that discuss the differences between epistemic modal adverbs and adjectives (Piñón 2006, 2009; Ernst 2009; Nilsen 2004) that, in such contexts, the 'all adverb conjunction' (12) is infelicitous while the 'adjective-adverb conjunction' (11) is felicitous. We will take issue with this observation, and provide evidence which shows that while there are differences, they are subtler ones.

3. Theoretical basis

The theory that we adopt in this paper, which accounts for the abovementioned differences between epistemic modal adverbs and adjectives and underlies the experiment in the next section, is provided in Wolf (2015a, 2015b). Wolf explains the differences between epistemic modal adverbs and adjectives as differences between 'high' and 'very high' modals. Adopting the terminology and distinction between 'low' (root) modals which are located right above VP and 'high' (epistemic) modals which are located right above TP from Hacquard (inter alia 2006, 2010), Wolf proposes another location for epistemic modals which modify illocutionary force and are thus 'very high' – at ForceP (cf. Rizzi 1997). Epistemic modal adjectives correspond to 'high' modals and epistemic modal adverbs correspond to 'very high' modals. The former are truth-conditional and the latter use-conditional (on the expressive dimension and use-conditionality, see Potts 2007; Gutzmann 2012; Gutzmann 2015). Truth-conditional epistemic modals convey possibilities and necessities in the same manner represented by the prevalent theory of modality, while use-conditional epistemic modals convey a degree of strength by which the speaker perform the assertion, i.e. the degree of confidence the speaker has regarding the prejacent.

Formally, the theory minimally modifies Stalnaker's (1978) system such that in addition to the common ground, the conversational context registers assertions which were previously performed and are currently under negotiation (see e.g. Ginzburg 2012; Farkas and Bruce 2010, for similar conversational registers). Each of these assertions is an expression of an information state (cf. Groenendijk Stokhof and Veltman 1995), represented in probabilistic terms (cf. (Lassiter 2011b; Yalcin 2012), of some conversational participant with regards to a proposition. It is represented by the following assertion operator:

(13) $A_x <S,C>$

In prose, the speaker x asserts propositional content C with a degree of strength S. The assertion operator itself is represented by the following shorthand probability function:

(14) $A_x P(\varphi) = v$

In prose, the speaker x asserts the probability function P which yields some probability value v when applied to propositional content φ. This value is defined on the speaker's information state i.e. the probability space of the speaker x and stands for the degree of belief of x in φ, which is the degree of strength for the sincerity condition of assertion. This degree of strength serves as *the* degree of strength of the assertion.

While an assertion is under *negotiation*, i.e. from the moment the assertion is performed and until it is accepted or rejected by conversational participants, it resides in the *Negotiation Zone* (NZ). The NZ is a set of assertion operators pertaining to various propositions. The manner by which conversational participants decide whether to accept or reject assertions is through an activation of a *mixture model*:

$$(15) \quad P(\varphi) = \sum_{i=1}^{n} w_i P_i(\varphi)$$

If the value of the mixture model surpasses some contextual threshold of acceptance, by assumption *high*, then the assertion is accepted and φ is updated into the common ground, i.e. the probability value assigned to φ becomes 1, and all information states in which the probability of φ is less than 1 are removed from the common ground. The difference between the standard Stalnakerian context update and the probabilistic context update proposed here, is as follows – figure 1 depicts a standard context update in which a proposition φ is added to the common ground thereby intersecting with the initial context set (CS). **Figure 1:**
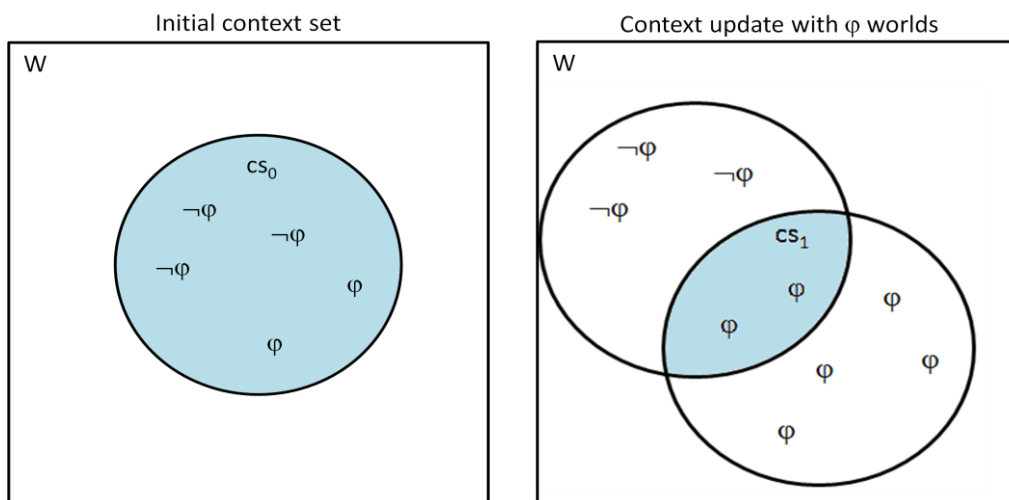
Figure 1: Standard context update.

The figure on the left depicts the initial context set as a set of worlds. Since nothing is known about φ, some of the worlds are φ worlds and others are *non-φ* worlds. The figure on the right depicts the new state of discourse once φ is accepted into the common ground – the proposition φ, a set of φ worlds, is intersected with the initial context set to yield the new one.

The initial context set in this paper is richer - it is composed of probability spaces, hence a more accurate representation of the initial probabilistic context set is as in **figure 2:**
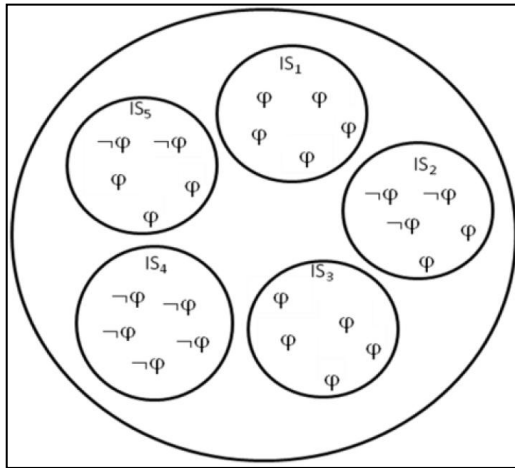
Figure 2: Probabilistic context set.

As can be seen, the probabilistic context set contains probability spaces rather than possible worlds, when each probability space is an information state *IS*.

We proceed with formal representations of non-modalized assertions, epistemic modal adjective assertions and epistemic modal adverb ones. When a speaker asserts a standard non-modified assertion the representation is:

(16) The dog is on the lawn
    A_x P (on-the-lawn(the-dog)) ≥ high

In prose, the speaker asserts the propositional content 'the dog is on the lawn' with a degree of strength which is equal to or greater than *high*.

If this assertion is accepted and updated, this assertion's Context Update Effect (CUE) will be to remove all information states except from figure 2's IS_1 and IS_3 from the context set, since those are the information states in which the propositional content has a probability of 1.

When a speaker asserts an utterance containing an epistemic modal adjective such as *possible*:

(17) It's possible that the dog is on the lawn.
    A_x P (P(on-the-lawn(the-dog)) > 0) ≥ high

The speaker asserts the propositional content 'it's possible that the dog is on the lawn', represented in probabilistic terms, i.e. 'the probability that the dog is on the lawn is greater than 0', with a degree of strength which is equal to or greater than *high*. Note that the degree of strength for a modal adjective-modified assertion is the same as the degree of strength for non-modified assertion, thus the chances of this assertion to be accepted by the hearer(s), everything else being equal, are the same as the chances of any non-modified assertion. Also note that the type of modal adjective does not affect the degree of strength but only the propositional content. If this assertion is accepted and updated, this assertion's CUE will be removing IS_4 from the

context set, since this is the only information state in which the propositional content has a probability of 0.

The following are representations of the other modal adjectives-modified utterances:

(18) It's probable that the dog is on the lawn.
    A_x P (P(on-the-lawn(the-dog)) > 0.5) $\geq$ high

(19) It's certain that the dog is on the lawn.
    A_x P (P(on-the-lawn(the-dog)) = 1) $\geq$ high

We assume, following Yalcin (2010) and Lassiter (2011) that the degree assigned to *probable* is greater than 0.5. We also assume that the degree assigned to *certain* is the same as the degree assigned to necessity modals, i.e. 1 corresponding to full certainty. The CUE of (18) is to remove all information states except from IS_1, IS_3, and IS_5 from the context set, and the CUE of (19) is to remove all information states except from IS_1, and IS_3 from the context set. Note that the CUE of (19) and (16) is the same, but the conversational impact is different. In (16) the speaker proposes to make the propositional content common ground, and in (19) the speaker claims that this propositional content is already common ground. Also note the entailment patterns – the stronger claims (19) and (16) illocutionary entail[5] the weaker ones (18) and (17) since the CUE of the former is a subset of the CUE of the latter.

The representations of epistemic modal adverbs' modified assertions are:

(20) The dog is possibly on the lawn.
    A_x P (on-the-lawn(the-dog)) > 0

(21) The dog is probably on the lawn.
    A_x P (on-the-lawn(the-dog)) > 0.5

(22) The dog is certainly on the lawn.
    A_x P (on-the-lawn(the-dog)) = 1

The formulas state that the speaker asserts the propositional content 'the dog is on the lawn' with the degrees of strength equal to or greater than 0 (for *possibly*), to 0.5 (for *probably)* and equal to 1 (for *certainly*). Note the difference between modal adjectives and modal adverbs – the former modify the propositional content while the latter modify the degree of assertion. Note the similarity between epistemic modal adverbs and adjectives – both are represented by the same degrees of probability, since the lexical root of both is the same. The difference is a matter of scope – epistemic modal adverbs modify the whole speech act and therefore scope over the

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[5] An illocutionary act A_1 illocutionarily entails the act A_2 if it is impossible to perform A_1 without thereby performing A_2 (Searle and Vanderveken 1985).

propositional content, and epistemic modal adjectives modify the propositional content and therefore have narrow scope.

There are differences in terms of conversational effects as well. If accepted, the CUE of all of the modal adverbs-modified assertions is the same as the CUE of non-modalized assertions, i.e. removing all information states except from IS_1, and IS_3 from the context set. However, asserting a modal adverb-modified utterance without the corresponding degree of belief is insincere. Thus, only the individuals holding information states IS_1, and IS_3 can sincerely assert (22), only the individuals holding IS_1, IS_3 and IS_5 can sincerely assert (21) and only the individuals holding IS_1, IS_3, IS_5 and IS_2 can sincerely assert (20).

Hence, the data in section 2 is explained: embeddability of modal adjectives is easier than modal adverbs because the former are part of the propositional content while the latter modify the speech act. Conversational agreements and disagreements target utterances including epistemic modal adjectives because they are conversational moves that determine whether or not the asserted content will be part of the common ground, and not whether the whole speech act together with its modification will, hence epistemic modal adverbs are left out. With regard to the *reason to assert* diagnostic, the scenario is reason enough to assert the epistemic modal adjective utterance because the speaker only asserts a possibility. The scenario is, however, not reason enough to assert the epistemic modal adverb, because in this case the speaker asserts (albeit with a *low* degree of force) the actuality of Danny's victory.

As for Nilsen's contrast – repeating the examples in (11) - (12):

    (23) It's possible that Le Pen will win even though he certainly won't.
    (24) #Le Pen will possibly win even though he certainly won't.

Following the formal representations presented above, these examples are represented respectively as:

    (25) A_x P (P(win(Le-Pen)) > 0) ≥ high $\bigwedge$ A_x P (¬win(Le-Pen)) = 1
    (26) A_x P(win(Le-Pen)) > 0 $\bigwedge$ A_x P (¬win(Le-Pen)) = 1

The difference between the two assertions stems from the interplay between modification of the propositional content and modification of the speech act. In (25) the speaker asserts the propositional content 'it's possible that Le Pen will win' with the default degree of assertion *high*, and asserts the propositional content 'Le Pen will not win' with the degree of assertion 1 which corresponds to certainty. In (26) the speaker asserts the propositional content 'Le Pen will win' with the default degree of assertion *high*, and asserts the propositional content 'Le Pen will not win' with the degree of assertion 1 which corresponds to certainty.

Starting with the more straightforward 'all adverb' example (24), which is considered infelicitous in Nilsen. We agree that this is a simple example of an infelicitous, in fact contradictory, utterance. This is explained by the theory of this paper by (26) being *unassertable*. This is

because the speaker can't sincerely assert a proposition with a degree of belief of greater than 0 and its negation with a degree of belief of 1.

The 'adjective-adverb' sentence in (23) is judged felicitous by Nilsen, but the theory of this paper predicts it to be infelicitous. Specifically, (25) being *assertable but non-updatable*. The speaker can have a fully certain personal belief that a proposition is false, while acknowledging that at the time of utterance other conversational participants, i.e. other information states within the Probabilistic Common Ground (PCG) consider said proposition possible. However – the two conjuncts can't be updated into the PCG since the speaker is also a conversational participant, hence a member of the set of probability spaces composing it, and the speaker's beliefs in the 2nd conjunct contradict the common beliefs in the 1st. It is therefore important to ascertain whether sentence (23) is considered felicitous or not. We set out to test this issue experimentally.

4. Processing epistemic modal adverbs and adjectives

4.1. Predictions and rationale

Nilsen's contrast again:

(27) It's possible that Le Pen will win even though he certainly won't.

(28) #Le Pen will possibly win even though he certainly won't.

Following the theory presented in the previous section, we aim to check a couple of things. **First**, whether the adjective-adverb conjunct is actually felicitous, when the **prediction** stemming from the theory is that it isn't. This prediction goes together with the prevalent theory of modality and against the theory in Nilsen (2004). Does this mean that we claim no difference between epistemic modal adverbs and adjectives? No, for the following reasons. Firstly, recall that the empirical data in section 2 establishes the differences between epistemic modal adverbs and adjectives. Secondly, our claim is that while both sentences are infelicitous, they are infelicitous at *different context update stages*. Reiterating the point made in the previous section, we claim that the 'adverb-adverb' conjunct is *unassertable* i.e. (28) mean that the speaker asserts the contradictory propositions 'Le Pen will win' and 'Le Pen will not win', the first with a low degree of certainty and the second with a full degree of certainty. The propositions contradict, and the degrees of certainty are incompatible. Note that if the degree of strength of the second conjunct were *less* than full, we predict that there wouldn't be any contradiction, which is indeed the case:

(29) Le Pen will possibly win even though he *probably* won't.

(27), on the other hand is *assertable but not updatable,* i.e. it passes the assertion stage which takes into consideration both the propositional content and the source of evidence (i.e. the conversational participants whose degree of certainty is at issue) but cannot pass the context update stage, which is only concerned with propositional contents, and those are contradictory.

The **second prediction,** following this rationale, is therefore that since the sentences fail at different context update stages, there would be a difference in reaction times. The infelicity of the adverb-adverb conjunct arises at the first stage of context update, i.e. it cannot pass from the assertion performance stage into the evaluation stage. Hence, we predict a relatively short reaction time. The infelicity of the adjective-adverb conjunct arises at a later stage, i.e. it cannot pass from the evaluation stage into the context update stage. Hence, we predict a longer reaction time. This prediction goes *against* the prevalent theory of modality and *with* the (spirit of) Nilsen (2004).

4.2. Experimental design

We manipulated the type of the modal in the first conjunct. This modal was either an epistemic modal adjective, i.e. a truth-conditional 'high' modal or an epistemic modal adverb, i.e. a use-conditional 'very high' modal. The sentences were Nilsen-type ones, to which we made the following modifications: using the contrastive conjunct *but* instead of Nilsen's 'even though' in order to reduce the extra complexity inherent to *even*. Replacing the negation at the end of the second conjunct with an antonym in order to reduce the complexity of another operator. Providing a context via a profession. Balancing the gender, alternating between male and female common names. Resulting in sentences of the following type[6]:

Adjective-adverb conjuncts:

(30) It's possible that Jane the actress will accept the job but she will certainly refuse it.

Adverb-adverb conjuncts:

(31) John the gambler will possibly win the game but he will certainly lose it.

There were 16 experimental items, composed of 8 adjective-adverb conjuncts and 8 adverb-adverb conjuncts. In order to control the sentential contexts, the items were used in two versions, turning the adjective-adverb conjuncts of version A into adverb-adverb conjuncts in version B, in the following manner:

(32) Jane the actress will possibly accept the job but she will certainly refuse it.

(33) It's possible that John the gambler will win the game but he will certainly lose it.

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[6] The preamble in which participants are provided with instructions and a practice session states that both conjuncts occur simultaneously, so as to avoid an interpretation of (30) where Jane refuses the job at some time but accepts it at another time.

There were also 16 control items, composed of uncontroversially felicitous and infelicitous sentences. Among the felicitous, we used possibility adjective-adverb or adverb-adverb conjuncts such as:

(34) It's possible that Patricia the rocker will admit the addiction but she will possibly deny it.

(35) James the banker will possibly authorize the payment but he will possibly withhold it.

Felicitous sentences with no modals:

(36) Jennifer the painter will finish the painting but she will hide it.

Infelicitous necessity adjective-adverb or adverb-adverb conjuncts:

(37) It's certain that David the lawyer will accept the settlement but he will certainly deny it.

(38) Elizabeth the athlete will certainly complete the marathon but she will certainly quit it.

Infelicitous sentences with no modals:

(39) Christopher the mayor will accept the petition but he will reject it.

4.3. Methods

We used two different experimental tasks: **acceptability judgments** based on a 7 point Likert scale, and binary acceptability judgments in which we also checked for **reaction times (RT)**. In the Likert task, subjects were instructed to rate the degree of sentence quality of the sentences from 1 to 7, 1 being the best – completely coherent, and 7 being the worst – completely incoherent. The sentences were presented in a randomized order with an attention test presented half-way through the experiment.

The **RT** task used a jspsych (http://www.jspsych.org/) toolbox for javascript. We ran a Rapid Serial Visual Presentation (RSVP) paradigm. Each word was presented for 300ms with 150ms interval between each word. Participants were instructed to decide whether a given sentence was "good and coherent" or "bad and incoherent" by clicking 'z' or 'm' respectively. Analysis was performed only from the appearance of a decision screen following the last word of the sentence. Again, sentences were randomized between subjects with an attention test prompting half-way through.

Participants were recruited over Amazon Mechanical Turk (cf. Sprouse 2011 on Amazon Mechanical Turk's reliability as an experimental tool). 50 subject participated in the Likert experiment and 90 participated in the reaction time experiment, all native speakers of English.

4.4. Results

Beginning with the acceptability judgments in the Likert task experiment, the following figure shows the means of participants' judgments. **Figure 3:**
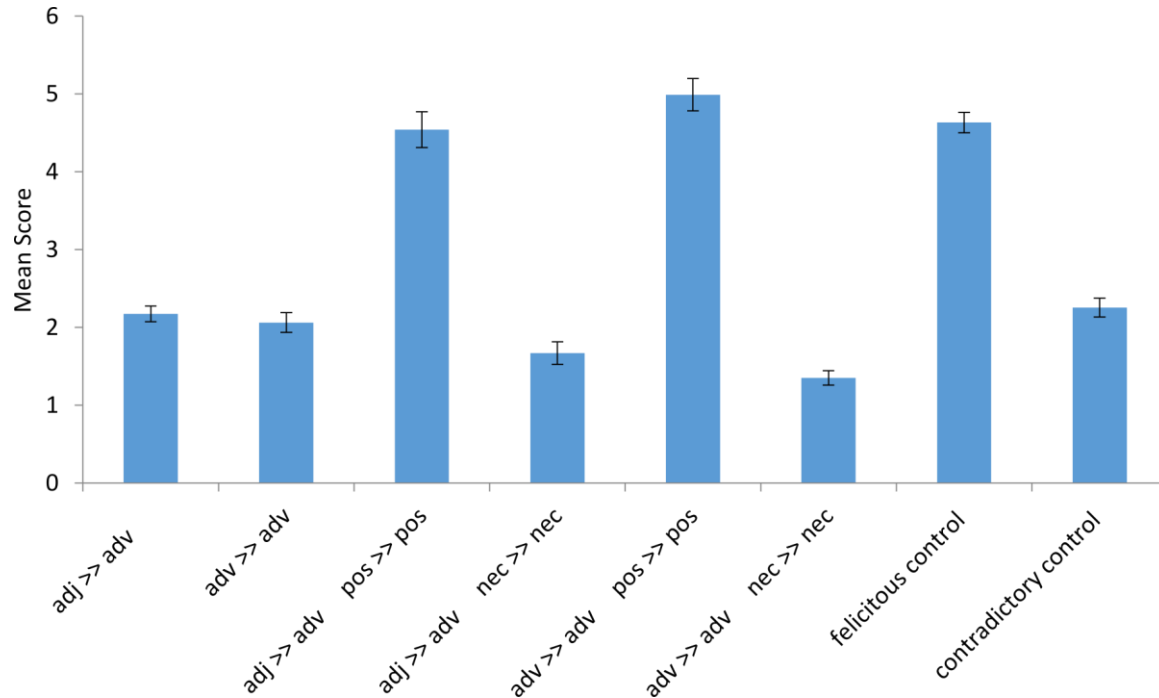

Figure 3: Mean score in each condition. Error bars denote standard errors.

A paired sample t-test performed on the adjective-adverb and adverb-adverb conjuncts showed that they were rejected in pretty much the same way, with no significant difference [$t(49) = 1.35$, $p = .18$]. On the other hand, repeated Measures ANOVA with the adjective-adverb and adverb-adverb conjuncts, felicitous and contradictory control items reveals significant difference [$F(3,147) = 149.76$, $p < .001$]. Post hoc comparisons show that this effect stems significantly from the mean score of the felicitous control items to be higher than the rest [$F(1,49) = 219.44$, $p < .001$] i.e. the adjective-adverb and adverb-adverb conjuncts are judged together with the contradictory control. Furthermore, no significant difference was observed from contrasting the adjective-adverb and adverb-adverb conjuncts with the contradictory control [$F(1,49) = 1.92$, $p = .17$].

Proceeding with the RT (RSVP) experiment, the following figure depicts the acceptability judgments in this task. **Figure 4:**
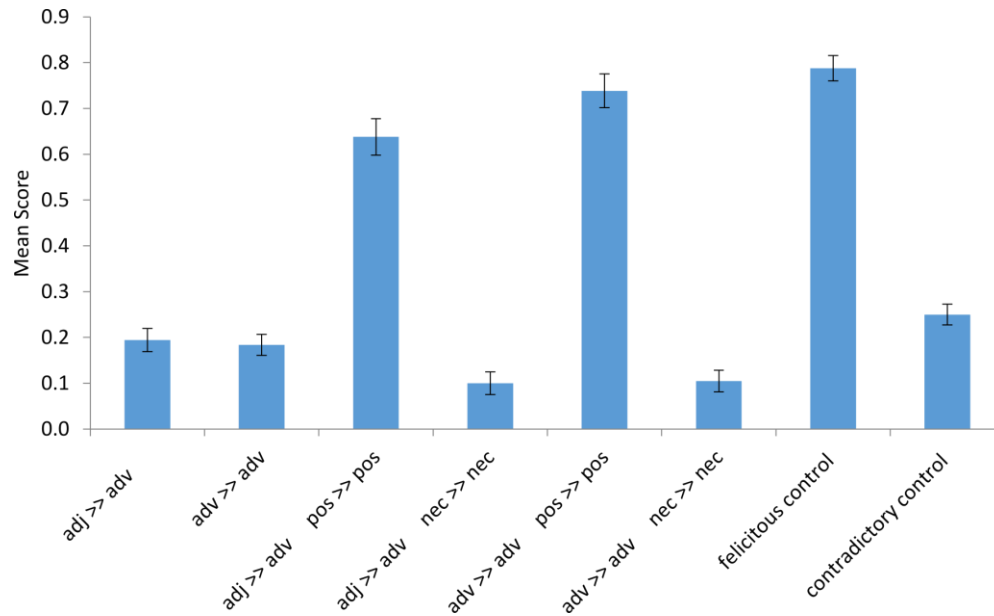
Figure 4: Mean score in the RSVP task. Error bars denote standard errors. Some observations were not taken into account since the participant clicked a different key other than 'm' or 'z'.

We first analyzed the scores given to the different constructions, and the results are similar to the previous experiment. Again, a paired sample t-test of adjective-adverb and adverb-adverb conjuncts shows that they are judged the same, with no significant difference [t(84) = 0.08, p = .93]. Interestingly, Repeated Measures ANOVA with the adjective-adverb and adverb-adverb conjuncts, felicitous and contradictory control items reveals significant difference [F(3,80) = 176.69, p < .001] while post hoc comparisons shows this effect stems significantly from the mean score of the felicitous control items being higher than the rest [F(1,80) = 286.79, p < .001]. A significant difference was also observed from contrasting the adjective-adverb and adverb-adverb conjuncts with the contradictory control [F(1,80) = 5.94, p = .017]. The picture is different when we consider reaction times. **Figure 5:**
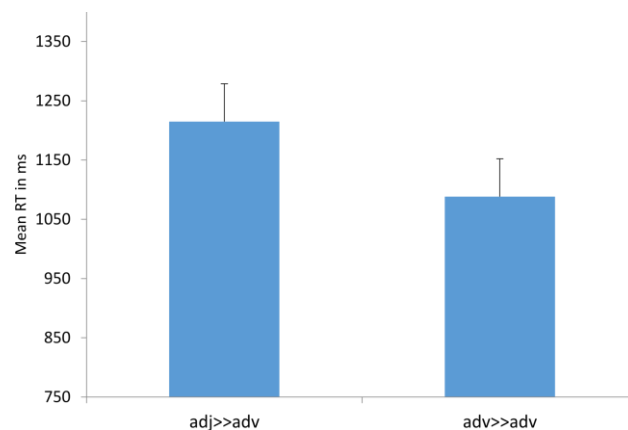

Figure 5: Mean RT. Error bars denote standard error of the mean difference.

We performed a paired-sample t-test on mean RT between the conjuncts. N=90, three subjects were excluded due to failure in attention test. In accordance with our assumption, we found a significant effect in which participants preformed slower on the adjective-adverb trials compared to the adverb-adverb ones [t(86) = 1.98, p = .05].

4.5. Discussion

The first hypothesis, i.e. that both the adjective-adverb and adverb-adverb conjuncts would be infelicitous is corroborated. As can be seen in the Likert results, the adjective-adverb and adverb-adverb conjuncts pattern together with the infelicitous control items. There is no significant difference between the conjuncts themselves, and there is no significant difference between the conjuncts and the contradictory control. There is however a significant difference between the conjuncts + contradictory control and the felicitous control, when the latter has higher values than the former.

Moreover, the results of the Likert acceptability judgment task nicely match the results of the RT judgment task, i.e. the adjective-adverb and adverb-adverb conjuncts as well as the infelicitous control items receive low acceptability scores while the felicitous control items receive high acceptability scores. In this task both of the conjuncts received significantly *lower* scores than the contradictory control, marking them, of course, as contradictory as well.

As for the second hypothesis, i.e. that in terms of reaction times adjective-adverb conjuncts will take longer to process than the adverb-adverb conjunct, this is also corroborated with a significant effect. While this establishes that there are differences, the effect is not as significant as we would like it to be. We speculate that this is due to the multiplicity of control items, and hypothesize that in a minimal experiment contrasting adjective-adverb and adverb-adverb conjuncts directly the effect would be bigger, but this is a matter for future research.

The two experiments complement each other in a way that dovetails between the prevalent theory of modality and Nilsen's theory. Experiment 1 established that Nilsen's contrast is not really a contrast, thereby supporting the prevalent theory of modality. Experiment 2 establishes that there are differences between epistemic modal adverbs and adjectives in terms of processing time, thereby pointing the need for a revision of the prevalent theory of modality. This revision may be minimal, if we only consider epistemic modal adverbs and adjectives[7]. But there are data that show similar differences to the ones seen here, in the epistemic modal auxiliary domain (cf. Lyons 1977; Papafragou 2006; Portner 2009; Wolf 2015a), which point to the need to reconsider the epistemic modality realm in general.

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[7] For example, Hacquard (2013) distinguishes between *grammatical modality* inherent to modal auxiliaries and *lexical modality* inherent to e.g. adverbs and adjectives.

5. Conclusion

This paper presents empirical and new experimental data on epistemic modal adverbs and adjectives. These data support the view that there is a distinction between these two types of epistemic modals, and suggest that this distinction manifests both in the truth-conditional level and the use-conditional one, with implications on the context update process.

We propose expansions to the prevalent Kratzerian theory of modality and the prevalent Stalnakerian theory of context update and put these proposals to the test by two experiments. Both experiments have an acceptability judgment component, and the second experiment adds a reaction time component. In terms of acceptability judgments, the experimental results support the proposal of the abovementioned differences, specifically the proposal to distinguish between truth-conditional and use-conditional epistemic modality. In terms of reaction times, the experimental results support the proposal to add another level to the context update process, namely the level of evaluation before updating propositions into the common ground.

We hope that the paradigm presented here will inspire the investigation of further theoretical questions concerning epistemic modal adverbs and adjectives and the nature of epistemic modality and the assertion process.

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Complete and true: A uniform analysis for mention some and mention all[1]

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Abstract.   This paper provides a uniform analysis for the interpretations of indirect mention-some questions and indirect mention-all questions. The main goal of this paper is to characterize the readings that are sensitive to false answers, which are usually called "intermediately exhaustive" readings in the case of mention-all. To capture mention-some grammatically, I adopt Fox's (2013) view that "completeness" amounts to Max-informativity, not exhaustiveness. Next, I argue that the "sensitivity to false answers" in direct questions is a matter of quality, not a result of exhaustification (compare Klinedinst & Rothschild 2011). Finally, I present a principled explanation as to why some false answers are more tolerated than the others.

Keywords: Questions, exhaustivity, mention-some, false answers

1. Introduction

Most *wh*-questions admit only exhaustive answers. For example, to properly answer (1), the addressee needs to specify all the attendants to the party, as in (1a), which we call a "mention-all (MA) answer". If the addressee can only provide a non-exhaustive answer like (1b), he would have to indicate an ignorance inference in some way, such as marking the answer with a prosodic rise-fall-rise contour (indicated by '.../'); if (1b) is not properly marked, such as taking a falling tone (indicated by '\'), it would yield an undesired exhaustivity inference.

(1)   Who came the party? (*w: only John and Mary came to the party.*)
   a.   John and Mary did.
   b.   John did .../   ⤳ *I don't know who else did.*
      L H*   L-H%
   c.   # John did.\   ⤳ *Only John did.*
      H*   L-L%

In contrast, ◇-questions, namely *wh*-questions containing a possibility modal, admit both exhaustive and non-exhaustive answers. For instance, (2) can be naturally answered by specifying one or all of the chair candidates. Crucially, the non-exhaustive answer (2b) does not need an ignorance mark: it does not yield an exhaustivity inference even if it takes a falling tone. Due to this difference, we call (2b) a "mention-some (MS) answer" while (1b) a "partial answer". Questions admitting and rejecting MS answers are called "MS questions" and "MA questions", respectively.

(2)   Who can chair the committee? *(w: only John and Mary can chair; one chair only.)*

    a.   John and Mary can.\\

    b.   John can.\\ $\not\rightsquigarrow$ *Only John can chair.*

Earlier works notice two forms of exhaustivity involved in interpreting indirect MA questions, namely *weak exhaustivity* (Karttunen 1977) and *strong exhaustivity* (Groenendijk & Stokhof 1984). Consider (3) for instance. The weakly exhaustive (WE) reading only requires John to know the MA answer as to *who came*, while the strongly exhaustive (SE) reading also requires John to know the MA answer as to *who didn't come*. Recent works (Klinedinst & Rothschild 2011, Spector & Egré 2015, Uegaki 2015, Cremers & Chemla 2016) start to consider an intermediate form of exhaustivity: stronger than WE but weaker than SE, the intermediately exhaustive (IE) reading requires John to know the MA answer as to *who came* and <u>have no false belief as to *who came*</u>. I call the underlined condition "be sensitive to false answers".

(3)   John knows who came.   *(w: among the three considered individuals abc, only ab came.)*

    a. John knows that a and b came.   **WE**

    b. John knows that a and b came; and John knows that c did **not** come.   **SE**

    c. John knows that a and b came; and **not** [John believes that c came].   **IE**

WE and SE have relatively limited distributions (Heim 1994, Guerzoni & Sharvit 2007, Nicolae 2013, Uegaki 2015, a.o.). In general, indirect questions with a non-factive verb (e.g., *tell*, *predict*) cannot take SE, while those with a factive verb (e.g., *know*, *remember*) cannot take WE. In contrast, as experimentally validated by Cremers & Chemla (2016), IE readings are available to most indirect questions, including those with a non-factive verb as well as those with a cognitive factive.

George (2013) observes that indirect MS questions also have readings sensitive to false answers, which are similar to the IE readings of indirect MA questions. Consider the scenario described in (4): Italian newspaper is available at Newstopia but not PaperWorld; both John and Mary know a true MS answer as to *where one can buy an Italian newspaper* (viz., *at Newstopia*), but Mary also believes a false answer, namely *that one can buy an Italian newspaper at PaperWorld*. Intuitively, there is a prominent reading under which (4a) is true while (4b) is false.

(4)

Italian newspaper available at ...	*Newstopia?*	*PaperWorld?*
Facts	*Yes*	*No*
John's belief	Yes	?
Mary's belief	Yes	Yes

    a. John knows where one can buy an Italian newspaper.   True

    b. Mary knows where one can buy an Italian newspaper.   False

It is debatable whether the reading described above for (4a-b) is exhaustive (see section 3.1.2). To be theory neutral, for both MA questions and MS questions, I call the readings that are sensitive to false answers "FA-sensitive readings". I divide the truth conditions of an FA-sensitive reading into two parts, namely *Completeness* and *FA-sensitivity*, roughly described in (5).

(5) *John told us Q.*
    a. John told us a complete true answer of Q.   Completeness
    b. John does not tell us any false answer of Q.   FA-sensitivity

The goal of this paper is to characterize the truth conditions of FA-sensitive readings. The crucial claims of the following sections are summarized as follows.

§2. Completeness amounts to Max-informativity, rather than exhaustiveness (Fox 2013).

§3. (i) FA-sensitivity is concerned with all types of false answers, not only those that are possible complete answers. (ii) FA-sensitivity is a matter of "quality", rather than a consequence of exhaustification (compare Klinedinst & Rothschild 2011). (iii) For indirect questions with an emotive factive, FA-sensitivity collapses under strong factivity.

§4. Experiments show (i) that FA-sensitivity is also concerned with false denials, and (ii) that FA-sensitivity exhibits asymmetries that vary by question-type.

§5. The asymmetry of FA-sensitivity is determined by the Principle of Tolerance.

2. Completeness

2.1. Completeness as exhaustiveness

Earlier works on questions consider only exhaustive answers as complete answers (Groenendijk & Stokhof 1984, Dayal 1996, a.o.). Since MS answers are not exhaustive, works following this line attribute the acceptability of MS to pragmatic factors: MS answers are partial answers that are sufficient for the conversational goal behind the question (Groenendijk & Stokhof 1984, van Rooij 2004, Schulz & van Rooij 2006). Consider the typical MS question *where can I get gas*. If the goal is just to find a local place to get gas, the addressee only needs to name one local gas station; if the goal is to investigate the local gas market, the addressee needs to list out all the local gas stations.

I agree that pragmatics plays a role in distributing MS in several respects; for instance, if a question is semantically ambiguous between MS and MA, a goal that calls for an exhaustive answer blocks MS. But, I doubt that pragmatics is restrictive enough to predict the limited distribution of MS. In the following, I provide two empirical arguments against the pragmatic account of MS. Both of the arguments are related to *mention-intermediate (MI) answers*. Those answers are, as

the name implies, non-exhaustive answers that are stronger than MS answers. I show that the pragmatic view cannot capture the differences between MS and MI: contrary to the case of MS, MI is unacceptable in root questions and embedded questions. **First**, MI answers must be ignorance-marked, even though they are informative enough to satisfy the question goal. For instance, assume that the goal of (6) is to find one qualified person to chair the committee. The MS answer (6a) does not have to be ignorance-marked. In contrast, while being sufficient for the pragmatic goal, the MI answer (6b), which names more than one but not all of the chair candidates, must to be ignorance-marked, otherwise it would yield an undesired exhaustivity inference. More generally, the obligatory ignorance-mark on (6b) suggests that whether an answer of a $\Diamond$-question can be read non-exhaustively is primarily determined by the grammatical structure of this answer, not the question goal: if not ignorance-marked, an individual answer like (6a) can be non-exhaustive, while a conjunctive answer like (6b) admits only an exhaustive reading.

(6)   Who can chair the committee?   *(w: only John, Mary, and Sue can chair; one chair only.)*

    a.   John.\ $\nrightarrow$ *Only John can chair.*

    b.   John and Mary.../

    b′. # John and Mary.\ $\rightsquigarrow$ *Only John and Mary can chair.*

Second, interpretations of indirect questions suggest that good answers are always "mention one (group)" or "mention all (groups)", as exemplified in (7a) and (7b), respectively. The conversational goal of a question, however, can be any "mention N (groups)" where N is a number in the available range. For instance, assume that the dean wants to meet with three chair candidates so as to make plans for the committee, then the goal of the embedded question in (7) would be "mention three". A pragmatic account predicts (7) to take the mention-three reading (7c), which however is infeasible. A semantic account does not have this prediction: complete answers derived from the possible logical forms of an MS-question are either mention one or mention all, not intermediate.

(7)   John knows who can chair the committee.

    a. For some x such that x can chair, John knows that x can chair. $\sqrt{}$

    b. For every x, if x can chair, John knows that x can chair. $\sqrt{}$

    c. For some xyz such that xyz each can chair, John knows that xyz each can chair. $\times$

2.2. Completeness as Max-informativity

To capture the availability of MS grammatically, Fox (2013) weakens the definition of completeness and proposes that any *maximally informative* (MaxI) true answer counts as a complete true answer. Given a set of propositions α, the strongest member of α is the unique member that entails all the members of α, while the MaxI members of α are the ones that are not asymmetrically entailed by any members of α. Consider (8a) and (8b) for illustrations. Q_w stands for the set of true

answers in w. Underlining highlights their MaxI true answers. The basic *wh*-question (8a) has and can only have one MaxI true answer, namely the MA answer. While the $\Diamond$-question (8b) has two MaxI true answers, both of which are MS answers.

(8)   a.   Who made the swimming team?   *(w: only a and d made the swimming team.)*
           $Q_w = \{a$ made the team, d made the team, $\underline{a \oplus d \text{ made the team}}\}$
      b.   Where can Sue get a bottle of wine?   *(w: wine is only available at store a and d.)*
           $Q_w = \{\underline{\Diamond(\text{Sue get a bottle from } a)}, \underline{\Diamond(\text{Sue get a bottle from } d)}\}$

I schematize Fox's basic idea as in (9), using Hamblin-Karttunen semantics of questions (Hamblin 1973, Karttunen 1977): the ANS-operator applies to the Hamblin set Q and the evaluation world w, returning the set of MaxI members of the Karttunen set Q_w.

(9) $\text{ANS}(Q)(w) = \text{MaxI}(Q_w)$, where $\text{MaxI} = \lambda\alpha.\{p : p \in \alpha \wedge \forall q \in \alpha[q \not\subset p]\}$

Compared with the earlier accounts on completeness, Fox's account leaves space for MS: it allows a non-exhaustive answer to be a good answer and a question to have multiple good answers. Nevertheless, Fox's account still misses some good MS answers. For instance in (10), both (10b-c) are intuitively good MS answers; but with a monotonic predicate *serve on the committee*, (10b) is asymmetrically entailed by (10c). Thus, Fox incorrectly predicts (10b) to be a partial answer.

(10)   Who can serve on the committee? *(w: the committee can be made up of G+D or G+D+J)*
       a. $\times$ Gennaro.   b. $\sqrt{}$ Gennaro and Danny.   c. $\sqrt{}$ Gennaro, Danny, and Jim.

Consider what (10b) precisely means. Intuitively, it means that *to form the committee, it is possible to have only Gennaro and Danny serve on the committee*. This reading involves exhaustivity scoping beneath the possibility modal *can*. To capture this intuition, I propose that the weak modal *can* embeds a covert exhaustivity O-operator associated with the *wh*-trace. This O-operator has a meaning approximating to the exclusive focus particle *only*: it affirms the prejacent and negates the alternatives that are not entailed by the prejacent. Moreover, the modal base of the teleological modal verb *can* is restricted to the set of worlds where the question goal is reached.
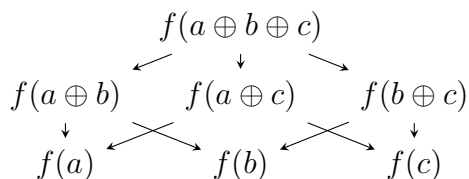
(11) $O(p) = \lambda w.p(w) \wedge \forall q \in \mathcal{A}lt(p)[p \not\subseteq q \to \neg q(w)]$ (Chierchia et al. 2013)
       (p is true, any alternatives of p not entailed by p are false.)
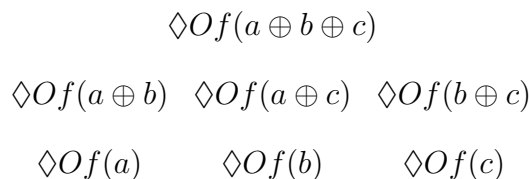
The O-operator creates a non-monotonic environment with respect to the *wh*-trace, which therefore breaks up the entailment relation from (10c) to (10b) and preserves both (10b-c) as good answers. Moreover, the embedded O evokes local exhaustivity and rules out (10a): it is false that *to form the*

committee, it is possible to have only Gennaro serve on the committee. Now, the answer space of an MA question and that of an MS question can be illustrated as in (12) and (13), respectively. In (12), an entailment relation holds consistently from the top to the bottom, as indicated by arrows; while in (13), all the answers are logically independent.[2]

(12)   Who served on the committee?

$$f(a \oplus b \oplus c)$$

$$f(a \oplus b) \quad f(a \oplus c) \quad f(b \oplus c)$$

$$f(a) \quad f(b) \quad f(c)$$

(13)   Who can serve on the committee?

$$\Diamond Of(a \oplus b \oplus c)$$

$$\Diamond Of(a \oplus b) \quad \Diamond Of(a \oplus c) \quad \Diamond Of(b \oplus c)$$

$$\Diamond Of(a) \qquad \Diamond Of(b) \qquad \Diamond Of(c)$$

The Completeness Condition of *John told us Q*, regardless of whether Q is MS or MA, can be uniformly stated as *John told us a MaxI true answer of Q*, as schematized below. It does not matter whether the existential semantics is attributed by an existential closure or a choice function.

(14) $\lambda w.\exists \phi \in \mathrm{Ans}(Q)(w)[\mathbf{told}_w(j, \phi)] = \lambda w.\exists \phi \in \mathrm{MaxI}(Q_w)[\mathbf{told}_w(j, \phi)]$

3. FA-sensitivity

3.1. The exhaustification-based approach

3.1.1. FA-sensitivity in MA questions

Klinedinst & Rothschild (2011) (K&R) account for IE readings using exhaustifications: exhaustifying (15a) yields an inference entailing (15b). Formally, K&R assume that the ordinary value of (15) is its WE reading, and that IE is derived by exhaustifying the WE inference. Exhaustification affirms the WE inference and negates all the propositions of the form "John told us ϕ" where ϕ is a possible MA answer of *who came* and is not entailed by the true MA answer of *who came*.

(15)   John told us who came.
       a.   If x came, John told us that x came.

---

[2]This paper considers only individual answers and questions with distributive predicates. See Xiang (2016) for discussions on higher-order answers and questions with collective predicates. The basic idea is as follows: the live-on set of *who* consists of not only individuals of type e but also generalized disjunctions and conjunctions (e.g., $a \oplus b \wedge c \oplus d = \lambda P_{est}\lambda w_s.P_w(a \oplus b) \wedge P_w(c \oplus d)$); therefore, the answer space of (1) is closed under conjunction.

(1)   Who formed a team? *(w: ab formed a team, cd formed a team)*
      $Q_w = \{f(a \oplus b), f(c \oplus d), f(a \oplus b) \wedge f(c \oplus d)\}$

b. If x didn't come, John didn't say to us that x came.

(16) a. $[\![\text{who came}]\!] = \lambda w \lambda w'. \forall x [\mathbf{came}_w(x) \rightarrow \mathbf{came}_{w'}(x)]$

b. $[\![p]\!] = \lambda w.\mathbf{told}_w(j,\ \lambda w'. \forall x [\mathbf{came}_w(x) \rightarrow \mathbf{came}_{w'}(x)])$ **WE**

    (John told Mary the MA answer as to *who came$_w$*)

c. $\mathcal{A}lt(p) = \{q \mid \exists w''[q = \lambda w.\mathbf{told}_w(j,\ \lambda w'. \forall x [\mathbf{came}_{w''}(x) \rightarrow \mathbf{came}_{w'}(x)])]\}$

    $(\{q \mid \exists w''[q = \text{John told Mary the MA answer of } \textit{who came}_{w''}]\})$

d. $[\![O(p)]\!] = \lambda w.p(w) \wedge \forall q \in \mathcal{A}lt(p)[p \not\subseteq q \rightarrow \neg q(w)]$ **IE**

    ($\lambda w.$ John only $\mathbf{told}_w$ us the true MA answer as to *who came$_w$*)

The WE inference of an indirect MA question amounts to the Completeness condition. Thus, using Hamblin-Karttunen semantics, we can re-schematize K&R's idea as follows.

(17) John told us Q.

a. $[\![p]\!] = \lambda w.\exists \phi \in \text{Ans}(Q)(w)[\mathbf{told}_w(j, \phi)]$ **WE**

b. $\mathcal{A}lt(p) = \{\lambda w.\exists \phi \in \alpha[\mathbf{told}_w(j, \phi)] \mid \exists w'[\alpha = \text{Ans}(Q)(w')]\}$

    $= \{\lambda w.\exists \phi \in \text{Ans}(Q)(w')[\mathbf{told}_w(j, \phi)] \mid w' \in W\}$

c. $[\![O(p)]\!] = \lambda w.p(w) \wedge \forall q \in \mathcal{A}lt(p)[p \not\subseteq q \rightarrow \neg q(w)]$ **IE**

3.1.2. FA-sensitivity in MS questions

In an indirect MS question like (18), there are two possible positions to place the O-operator: one position is immediately above the scope part of the existential closure, called "local exhaustification"; the other is above the existential closure, called "global exhaustification". In the following, I show that neither of the options derives the desired the FA-sensitivity inference.

(18) John told us [$_Q$ where we could get gas].

a. $\exists \phi$ [ϕ is a true MS answer of Q] [O [John told us ϕ]]   **Local exhaustification**

b. O [$\exists \phi$ [ϕ is a true MS answer of Q] [John told us ϕ]]   **Global exhaustification**

Local exhaustification is apparently infeasible. This operation yields the following truth conditions: first, John told us an MS answer as to *where we could get gas*; second, John didn't give us any answer that is not entailed by this MS answer. The second condition is too strong. For instance, if what John said was *we could get gas at place a and somewhere else*, which is strictly stronger than any MS answer, the sentence (18) would be predicted to be false, contra the fact.[3]

---

[3]One might suggest to stipulate that the local exhaustifier negates only false inferences. This option is however technically difficult and conceptually circular.

The option of global exhaustification seems to have a better chance of yielding the desired FA-sensitivity inference. As Danny Fox and Alexandre Cremers p.c. to me independently, *innocently exclusive exhaustification* (Fox 2007) yields an inference that is very close to the FA-sensitivity condition. While the regular exhaustifier O negates all the excludable alternatives (i.e., the alternatives that are not entailed by the prejacent of the exhaustifier), the innocently exclusive exhaustifier O_{IE} negates only *innocently (I)-excludable alternatives*. For a proposition p, an alternative q is I-excludable iff $p \wedge \neg q$ is consistent with negating any excludable alternative(s) of p.

(19)   a. $\text{Excl}(p) = \{q : q \in \mathcal{A}lt(p) \wedge p \nsubseteq q\}$
        b. $\text{IExcl}(p) = \{q : q \in \mathcal{A}lt(p) \wedge \neg \exists q' \in \text{Excl}(p)[[p \wedge \neg q] \to q']\}$
        c. $O_{\text{IE}}(p) = p \wedge \forall q \in \text{IExcl}(p)[\neg q]$

Using innocent exclusion avoids negating propositions of the form "John told us ϕ" where ϕ is a true MS answer or a disjunction involving at least one true MS answer as a disjunct. Consider (20) for instance. Using innocent exclusion, global exhaustification proceeds as follows. The prejacent of O_{IE} is a disjunction that coordinates all the true MS answers, as schematized in (20b). ϕ_a is short for the proposition *we could get gas at place* a. Alternatives are propositions of the form "John told us a member of α" where α is a possible set of complete answers, as list in (20c). Among these alternatives, only $\textbf{told}(j, \phi_c)$ is I-excludable. Hence, empolying O_{IE} yields a very appealing inference (20d): *John told us a true MS answer of Q, and didn't give us any false MS answer of Q.*

(20)   John told us [$_Q$ where we could get gas].
        (w: among the considered places abc, only ab sold gas)

        a. O_{IE} [$_S \exists \phi$ [ϕ is a true MS answer of Q] [John told us ϕ]]
        b. $\llbracket S \rrbracket = \lambda w. \exists \phi \in \text{Ans}(Q)(w)[\textbf{told}_w(j, \phi)] = \textbf{told}(j, \phi_a) \vee \textbf{told}(j, \phi_b)$
        c. $\mathcal{A}lt(S) = \{\lambda w. \exists \phi \in \alpha[\textbf{told}_w(j, \phi)] \mid \exists w'[\alpha = \text{Ans}(Q)(w')]\}$
            $= \left\{ \begin{array}{lll} \textbf{told}(j, \phi_a), & \textbf{told}(j, \phi_a) \vee \textbf{told}(j, \phi_b), & \textbf{told}(j, \phi_a) \vee \textbf{told}(j, \phi_b) \vee \textbf{told}(j, \phi_c) \\ \textbf{told}(j, \phi_b), & \textbf{told}(j, \phi_a) \vee \textbf{told}(j, \phi_c), & \\ \textbf{told}(j, \phi_c), & \textbf{told}(j, \phi_b) \vee \textbf{told}(j, \phi_c), & \end{array} \right\}$
        d. $\llbracket O_{\text{IE}}(S) \rrbracket = [\textbf{told}(j, \phi_a) \vee \textbf{told}(j, \phi_b)] \wedge \neg \textbf{told}(j, \phi_c)$

3.2. Problems with the exhaustification-based account

3.2.1. Problem 1: FA-sensitivity is not a scalar implicature

Treating FA-sensitivity as a logical consequence of exhaustifying Completeness amounts to saying that FA-sensitivity is a scalar implicature (SI) of Completeness. Nevertheless, FA-sensitivity

inferences do not behave like SIs. **First**, FA-sensitivity inferences are easily generated even in downward-entailing contexts. In (21a), appearing within the antecedent of a conditional, the scalar item *some* (unless focus-marked) does not evoke an SI. This is so because strengthening the antecedent weakens the entire conditional and violates the *Strongest Meaning Hypothesis* (Chierchia et al. 2013; Fox & Spector to appear) for exhaustifications: the use of an exhaustifier is marked if it gives rise to a reading that is equivalent to or weaker than what would have resulted in its absence. In (21b), however, while uttered as the antecedent of a conditional, the indirect question *Mary knows which speakers went to the dinner* still evokes an FA-sensitivity inference.

(21)   a. If [Mary invited some of the speakers to the dinner], I will buy her a coffee.
         $\not\leadsto$ If Mary invited some but **not all** speakers to the dinner, I will buy her a coffee.
   b. (w: *Barbara and Irene went to the dinner, but Uli didn't.*)
         If Mary knows which speakers went to the dinner, I will buy her a coffee.
         $\leadsto$ If [Mary knows that Barbara and Irene went to the dinner] $\wedge$
                      not [Mary believes that Uli went to the dinner], I will buy her a coffee.

Second, FA-sensitivity inferences are not cancelable. In (22a), the SI *that Mary did not invite all of the speakers to the dinner* can be easily cancelled, while in (22b) the FA-sensitivity inference *it is not the case that Mary believes that Uli went to the dinner* cannot be cancelled.

(22)   a. A: "Did Mary invite some of the speakers to the dinner?"
         B: "Yes. Actually she invited all of them."
   b. (w: *Barbara and Irene went to the dinner, but Uli didn't.*)
         A: "Does Mary know which speakers went to the dinner?"
         B: "Yes. #Actually also she believes that Uli went to the dinner."

One might suggest that FA-sensitivity inferences are special species of SIs which are mandatorily evoked and exceptionally robust. To assess this assumption, let us compare FA-sensitivity inferences with SIs that are mandatorily evoked in presence of the overt exhaustifier *only*. In (23) for instance, since the scalar item *some* is associated with *only*, its SI patterns like FA-sensitivity inferences: this SI can be generated within the antecedent of a conditional and cannot be cancelled.

(23)   a. If [Mary invited only SOME$_F$ of the speakers to the dinner], I will buy her a coffee.
         $\leadsto$ If Mary invited some but **not all** speakers to the dinner, I will buy her a coffee.
   b. A: "Did Mary invite only SOME$_F$ of the speakers to the dinner?"
         B: "Yes. # Actually she invited all of them."

Nevertheless, a difference arises in negative sentences. In (24b), associating *only* with the focused item over negation evokes a positive implicature, namely an indirect SI: *only* negates the negative alternative $\neg\phi_{\text{male}}$, yielding an indirect SI ϕ_{male}, as schematized in (24c).

(24)   a. Mary **only** invited some [female]$_F$ speakers to the dinner.

            ⤳ Mary did not invite any male speakers to the dinner. $\neg\phi_{\text{male}}$

     b. Mary **only** did <u>not</u> invite any [female]$_F$ speakers to the dinner.

            ⤳ Mary did invite some male speaker(s) to the dinner. ϕ_{male}

     c. $O\neg\phi_{\text{female}} = \neg\phi_{\text{female}} \wedge \neg\neg\phi_{\text{male}} = \neg\phi_{\text{female}} \wedge \phi_{\text{male}}$

If the FA-sensitivity inference were a mandatory SI, we would analogously predict that a negated indirect question like (25b) takes the LF (25c) and evokes an indirect SI **told**(m, ϕ_{uli}), namely the negation of the FA-sensitivity inference, contra the fact. Note that here the exhaustifier cannot be placed below negation, due to the Strongest Meaning Hypothesis.

(25)   (w: *Barbara and Irene went to the dinner, but Uli didn't.*)

     a. Mary told us which speakers went to the dinner.

            ⤳ Mary did not tell us that Uli went to the dinner. $\neg$**told**(m, ϕ_{uli})

     b. Mary did <u>not</u> tell us which speakers went to the dinner.

            ⤼ Mary told us that Uli went to the dinner.   **told**(m, ϕ_{uli})

     c. O **not** [Mary told us [$_Q$ which speakers went to the dinner]]

3.2.2. Problem 2: FA-sensitivity is concerned with partial answers

So far, the alternative set used by the exhaustification-based account includes only propositions that are possible complete answers. Hence, exhaustifying the Completeness condition only yields the requirement of avoiding false answers that are possible complete answers. The FA-sensitivity condition, however, requires to avoid all types of false answers, including those that can never be complete. For instance, (26) and (27) are intuitively false in the given scenarios, which suggests that the FA-sensitivity condition is also concerned with disjunctive partial answers like $\phi_c \vee \phi_d$.

(26)   John told us where we could get gas.   [Judgement: FALSE]

     a. Fact: a and b sold gas; c and d didn't.

     b. John said to us: "a, b, and somewhere else sell gas, which might be either c or d."

(27)   John told us who came.   [Judgement: FALSE]

     a. Fact: a and b came; c and d didn't come.

     b. John said to us: "a, b, and someone else came, who might be either c or d."

Moreover, interpretations of indirect MS questions show that FA-sensitivity is also concerned with false denials, which also are always partial. As seen in section 1, George (2013) has discussed false answers that are *over-affirming* (OA), namely overly affirming a possible answer that is false

in the evaluation world: Mary incorrectly believes that Italian newspapers are available at store B. Correspondingly, we should also check false answers that are *over-denying* (OD), namely denying a possible answer that is true in the evaluation world: Sue incorrectly believes that Italian newspapers are unavailable at store C. The truth value of (28c) reflects whether FA-sensitivity is concerned with OD: if OD is involved in FA-sensitivity, then there should be a reading under which (28a) is true while (28c) is false. It is a bit hard to judge whether (28c) is true or false (see explanation in section 5), but my experiments in section 4 do show that OD is involved in FA-sensitivity: (28c) received significantly less acceptances than (28a).

(28)

Italian newspaper available at ...	*A?*	*B?*	*C?*	FA-type
Facts	*Yes*	*No*	*Yes*	
John's belief	Yes	?	?	
Mary's belief	Yes	**Yes**	?	OA
Sue's belief	Yes	?	**No**	OD

    a. John knows where one can buy an Italian newspaper.   True

    b. Mary knows where one can buy an Italian newspaper.   False

    c. Sue knows where one can buy an Italian newspaper.   True or False?

Notice that, from indirect MA questions, we cannot tell whether FA-sensitivity is concerned with OD. In (29) for instance, the requirement of avoiding OD can be understood in two different ways. One way is to treat this requirement simply as a logical consequence of Completeness, given that (29a) entails (29c). The other way is to treat this requirement as part of FA-sensitivity and group it together with the condition (29b), given that both (29b-c) are concerned with false answers. Previous and other ongoing studies on FA-sensitivity (K&R 2011, Uegaki 2015, Roelofsen et al. 2014) take the former option; they predict that FA-sensitivity is only concerned with false answers that are possibly complete answers. But given that FA-sensitivity is concerned with OD in indirect MS questions, we should accordingly take the second option for indirect MA questions.

(29)   *John knows who came.*

        a. if x came, John believes that x came.

        b. if x didn't come, not [John believes that x came]   Avoiding OA

        c. if x came, not [John believes that x didn't come].   Avoiding OD

One might suggest to enlarge the alternative set based on the condition of *Relevance*: a proposition p is relevant to a question Q iff p is equivalent to the union of some cells of the partition yielded by Q (Heim 2011). This move, however, does not work for the exhaustification-based approach; it yields bad consequence in interpreting indirect MS questions. For instance in (30), it rules in not only inferences as to telling a false answer, like those in (30a-c), but also inferences as to telling

a true answer that is strictly stronger than an MS answer, such as (30d). Once (30d) is added into the alternative set, an exhaustification-based account would incorrectly predict (30) to be false in a discourse where John told us multiple accessible gas stations.

(30) John told us where we could get gas. *(w : a and b sell gas; c and d do not.)*
 a. OA: **told**(j, ϕ_c), **told**(j, ϕ_d)
 b. OD: **told**$(j, \neg\phi_a)$, **told**$(j, \neg\phi_b)$
 c. Partial: **told**$(j, \phi_c \vee \phi_d)$
 d. MA or MI: **told**$(j, \phi_a \wedge \phi_b)$

3.3. My analysis: A quality-based approach

I propose that FA-sensitivity is simply a matter of "Quality": only make true contributions.[4] Take (31) for instance, where Q can be either MA or MS. The FA-sensitivity condition of this indirect question is concerned with all types of false answers relevant to Q, not just those that can be complete. $\textsc{Rel}(Q)$ stands for the set generated from closing the Hamblin set Q under propositional connectives (negation, disjunction, and conjunction). For instance, if $Q = \{p, q\}$, then $\textsc{Rel}(Q) = \{p, q, \neg p, \neg q, p \wedge q, p \vee q, p \wedge \neg q, ...\}$. This FA-sensitivity condition does not negate any propositions about telling a true answer of Q, and hence it is free from the problem that we saw in (30).

(31) John told us Q.
 a. $\lambda w.\exists \phi \in \textsc{Ans}(Q)(w)[\textbf{told}_w(j, \phi)]$ **Completeness**
 (λw. John told$_w$ us a complete true answer of Q in w.)
 b. $\lambda w.\forall \phi \in \textsc{Rel}(Q)[\textbf{told}_w(j, \phi) \to \phi(w)]$ **FA-sensitivity**
 (λw. Every Q-relevant proposition that John told$_w$ us is true in w.)

In case that the question-embedding verb is factive, I predict that FA-sensitivity will collapse under factivity. For instance in (32), the emotive factive *be surprised* triggers a factive presupposition c *came*. Locally accommodating this presupposition does not change Completeness, but turns FA-sensitivity into a tautology. More concretely, (33b) is true as long as the factive presupposition is accommodated under negation, and (33c) is not implied because global accommodation causes presupposition failure.

(32) John is surprised at Q.
 a. $\lambda w.\exists \phi \in \textsc{Ans}(Q)(w)[\textbf{surprised}_w(j, \phi) \wedge \underline{\phi(w)}]$ **Completeness**
 (λw. John is surprised$_w$ at a complete true answer of Q in w)
 b. $\lambda w.\forall \phi \in \textsc{Rel}(Q)[\textbf{surprised}_w(j, \phi) \wedge \underline{\phi(w)} \to \phi(w)]$ **FA-sensitivity**
 (λw. every Q-relevant proposition that surprises$_w$ John and is true in w is true in w)

[4]I leave it open whether this condition is a grammatical constraint or a Gricean maxim.

(33)   John is surprised at who came.   *(w: among the considered individuals abc, only ab came.)*

    a. ⇝ John is surprised that ab came.   **surprise**$(j, \phi_a \wedge \phi_b)$

    b. ⇝ it is not the case that John is surprised that c came. $\neg[\mathbf{surprise}(j, \phi_c) \wedge \phi_c]$

    c. ↛ John isn't surprised that c came. $\neg\mathbf{surprise}(j, \phi_c)_{\phi_c}$

Puzzles arise in cases of cognitive factives. Spector & Egré (2015) speculate that the FA-sensitive (viz. IE) reading of (34) should be paraphrased as (34c) rather than (34a-b): to be more specific, in paraphrasing the FA-sensitivity inference, the factive verb *know* should be replaced with its non-factive counterpart *believe*, and the factive presupposition should be ignored.

(34)   John knows who came.   *(w: consider three individuals abc; only a and b came.)*

    a. × $\mathbf{know}(j, \phi_a \wedge \phi_b) \wedge \neg\mathbf{know}(j, \phi_c)_{\phi_c}$

    b. × $\mathbf{know}(j, \phi_a \wedge \phi_b) \wedge \neg[\mathbf{know}(j, \phi_c) \wedge \phi_c]$

    c. √ $\mathbf{know}(j, \phi_a \wedge \phi_b) \wedge \neg\mathbf{believe}(j, \phi_c)$

We need to explain two puzzles. **First**, why is that (34c) is more preferable than (34a-b)? The answer is simple: (34a) suffers presupposition failure, and (34b) is a tautology; therefore, whenever allowed, it is better to "deactivate" the factive presupposition of *know* in paraphrasing the FA-sensitivity inference. **Second**, why is that the FA-sensitivity inference of (33) keeps the factive presupposition of *be surprised* and accommodates it locally, contrary to the case in (34)? This contrast correlates with the general distinction between emotive factives and cognitive factives as presupposition triggers, as exemplified in (35): the factive presupposition triggered by the cognitive factive *discover* is defeasible, while that triggered by the emotive factive *regret* is not.

(35)   a. If someone *regrets* that I was mistaken, I will admit that I was wrong.

       ⇝ The speaker was mistaken.

    b. If someone *discovers* that I was mistaken, I will admit that I was wrong.

       ↛ The speaker was mistaken.

Earlier works have argued that emotive factives are strong triggers, while cognitive factives are weak triggers (Karttunen 1971, Stalnaker 1974). Recent theoretical and experimental works (Romoli 2014, Romoli & Schwarz to appear) argue that the presuppositions of soft triggers are actually scalar implicatures. The contrast between hard and soft triggers is far beyond the scope of this article, but whatever accounting for this contrast can also explain the contrast between (33) and (34) with respect to the FA-sensitivity inferences.

4. Experiments

The primary goal of the following experiments is to investigate whether false answers with OD are involved in the condition of FA-sensitivity. The experiment results show that OD is indeed involved in FA-sensitivity, and that FA-sensitivity exhibits asymmetries that vary by question-type.

4.1. Design

Did ... make the swimming team? *Could Susan buy a bottle of red wine at ...?*	*a*	*b*	*c*	*d*	Ans-type
Fact	*Yes*	*No*	*No*	*Yes*	
A1	**No**	?	No	Yes	OD
A2	?	No	No	Yes	MS
A3	Yes	?	No	Yes	MA
A4	Yes	**Yes**	?	Yes	OA

Table 1: Design of Exp-MA and Exp-MS

Exp-MA   K&R (2011) conducted a survey to establish the existence of IE. They stipulated that four individuals $abcd$ tried out for the swimming team, and that only ad made the team. Four sets of predictions (A1-A4 in Table 1) were made as to whether each individual made the team. For instance, A1 means that the agent predicted that d but not a nor c made the swimming team and that the agent was uncertain whether b made it. Next, they asked the participants to judge whether or not each prediction *correctly predicted who made the swimming team*. Each combination of responses corresponds to a reading of the indirect MA question x *predicted who made the swimming team*. For instance, the participants who chose IE would ideally accept A3 and reject the rest responses.

K&R were not particularly interested in OD. They removed the participants who accepted A1/A2 (viz., the participants who were tolerant of incompleteness) from their analysis. But this survey is helpful for studying the sensitivity to false answers in indirect questions: A1 and A4 represent answers with OD and answers with OA, respectively; A1 incorrectly predicted that a did not make the team, and A4 incorrectly predicted that b made the team. A2-A3 have no false predictions, but A2 violates Completeness. I renamed A1-A4 as OD/MS/MA/OA and re-analyzed the raw data.[5]

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[5]See here (http://users.ox.ac.uk/~sfop0300/questionsurvey/) for the raw data. This survey has no fillers. Thus I excluded only participants who were (i) non-native speakers, (ii) rejected by Amazon Mechanical Turk (MTurk), or (iii) with missing responses. 107 participants (out of 193) were kept in my analysis.

Exp-MS   I conducted a similar experiment for MS-questions on MTurk:[6] among the four liquor stores *abcd* at Central Square, only *ad* sold red wine; Susan asked her local friends *where she could buy a bottle of red wine at Central Square* and received four responses (A1-A4 in Table 1). Participants were asked to identify whether each response correctly answered Susan's question. Note here that A2 satisfies Completeness, contrary to the case in Exp-MA.

4.2. Results and discussions

Figure 1 and Figure 2 summarizes the proportions of acceptances by ANSWER in Exp-MA and Exp-MS, respectively. N stands for the sample size.
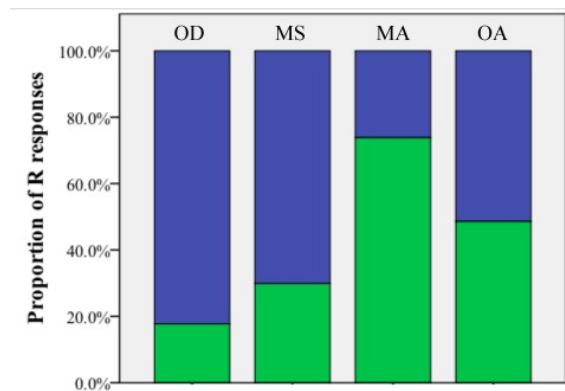
Figure 1: Proportion of acceptances by AN-SWER in Exp-MA ($N = 107$)
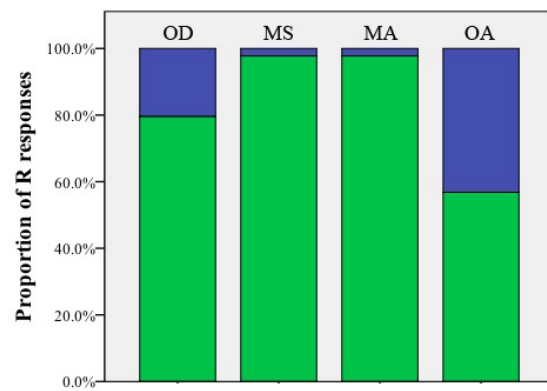
Figure 2: Proportion of acceptances by AN-SWER in Exp-MS ($N = 88$)

FA-sensitivity   For every two answers in each experiment, I fitted a logistic mixed effects model predicting responses by ANSWER.[7] All the models, except the one for MS versus MA in Exp-MS, reported a significant effect. These significant effects, especially the ones for OD versus MS/MA in Exp-MS, show that FA-sensitivity is concerned with both OA and OD.

Asymmetries of FA-sensitivity   Compared with OD, OA received significantly more acceptances in Exp-MA ($\hat{\beta} = 1.0952$, $p<.001$) but significantly less acceptances in Exp-MS ($\hat{\beta} = -0.7324$, $p<.005$). These results suggest asymmetries with respect to the sensitivity to OA and OD: OA is more tolerated than OD in MA questions, but less tolerated than OD in MS questions.

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[6]In Exp-MS, the four target items (A1-A4) and two fillers were randomized into 10 lists. I recruited 100 participants on MTurk. All the participants were required to have completed 90 HITs with the number of HITs approved no less than 50. All IP address were tied to the U.S. Based on the filler accuracy (100%), native language (English), and the completion rate (fully completed exactly one HIT), I kept 88 participants out of 100.

[7]A1 and A4 were coded as -1 and 1, respectively. Fomula: glmer(Choice $\sim$ Item + (1|WorkerId), data = mydata, family = binomial (link="logit"), verbose = TRUE)

What causes these asymmetries? One might argue that OD is less tolerated than OA in MA questions because OD even does not satisfy Completeness. But, the participants in Exp-MA who were tolerant of incompleteness (viz., the participants who accepted both MS and MA, $N=28$) rejected OD significantly more than OA (binomial test: 89%, $p<.05$). In other words, OD is consistently less tolerated than OA in MA questions, regardless of whether Completeness is concerned. Therefore, the asymmetries of FA-sensitivity vary by question-type, not result from Completeness.

5. Explaining the asymmetries of FA-sensitivity: Principle of Tolerance

I propose that a false answer is tolerated if it is not misleading: each response brings an update to the answer space, such as removing the incompatible answers or adding the entailed answers. If the questioner accepts this response, he would take any MaxI answer of the new answer space as a resolution and make decisions accordingly. If none of these MaxI answers leads to an improper decision (such as making the questioner go somewhere for gas where however has no gas), this response could be tolerated, even if it contains false information. For a MaxI answer not leading to an improper decision, it has to provide enough information that a complete true answer would do.

Formally, I propose that an answer is tolerated iff it satisfies the *Principle of Tolerance*, as defined in (36). In the following, I elaborate how this principle captures the asymmetries of FA-sensitivity.

(36)   **Principle of Tolerance**   An answer p is tolerated iff accepting p yields an answer space s.t. every MaxI member of this answer space entails a complete/MaxI true answer.

Figure 3 illustrates **the asymmetry of FA-sensitivity in MA questions**. The letter f stands for the predicate *made the swimming team* and $a/b/c$ for relevant individuals (e.g., $f(a) = \lambda w.\ a\ made_w$ *the swimming team*). Arrows indicate entailments. The shaded answers are the ones that entail the bottom-left answer $f(a)$. Underlining marks the MaxI answers of each answer space.
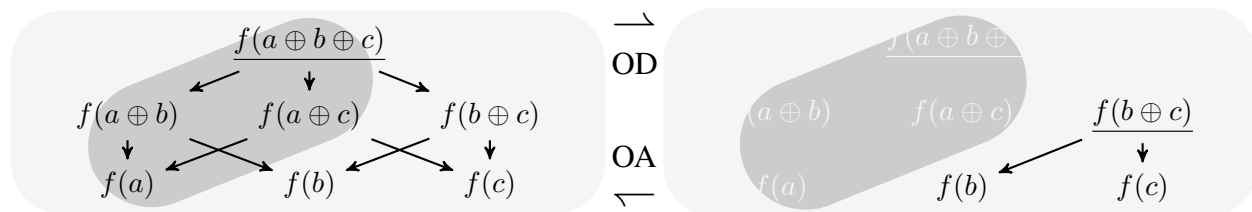

Figure 3: OA and OD in "who made the swimming team?"

OA is tolerated. Assume that only the unshaded answers are true, then the question has a unique MaxI true answer $f(b{\oplus}c)$. Due to the entailment relation among the answers, overly affirming $f(a)$ brings in all the shaded answers. The unique MaxI member of the updated answer space, namely

$f(a \oplus b \oplus c)$, entails the unique MaxI true answer $f(b \oplus c)$. In contrast, **OD is not tolerated**. Assume that all the present answers are true, then the question has a unique MaxI true answer $f(a \oplus b \oplus c)$. Due to the entailment relation among the answers, overly denying $f(a)$ subsequently excludes all the shaded answers. The MaxI member of the updated answer space, namely $f(b \oplus c)$, does not entail the unique MaxI true answer $f(a \oplus b \oplus c)$.

Figure 4 illustrates **the asymmetry of FA-sensitivity in MS-questions**. The letter f stands for the predicate *serve on the committee* and $a/b/c$ for relevant individuals. Due to the non-monotonicity of the local O-operator (see section 2.2), all the present answers are semantically independent; hence, the bottom-left answer is only entailed by itself (shaded).
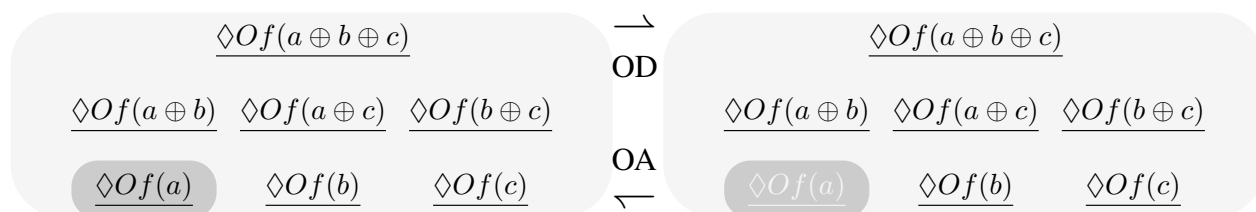

$$\Diamond Of(a \oplus b \oplus c) \qquad\qquad\qquad \Diamond Of(a \oplus b \oplus c)$$

$$\Diamond Of(a \oplus b) \quad \Diamond Of(a \oplus c) \quad \Diamond Of(b \oplus c) \qquad \Diamond Of(a \oplus b) \quad \Diamond Of(a \oplus c) \quad \Diamond Of(b \oplus c)$$

$$\Diamond Of(a) \qquad \Diamond Of(b) \qquad \Diamond Of(c) \qquad\qquad \Diamond Of(a) \qquad \Diamond Of(b) \qquad \Diamond Of(c)$$

OD

OA

Figure 4: OA and OD in "who can serve on the committee?"

OA is not tolerated. Assume that only the unshaded answers are true, then all of the unshaded answers are MaxI true answers. Overly affirming $\Diamond Of(a)$ only adds $\Diamond Of(a)$ itself to the answer space. $\Diamond Of(a)$ is a MaxI member in the updated answer space, but it does not entail any MaxI true answers. In contrast, **OD is tolerated**. Assume that all the present answers are true, then all of them are MaxI true answers. Overly denying $\Diamond Of(a)$ only removes $\Diamond Of(a)$ itself from the answer space. All the remaining answers are MaxI members of the updated answer space, and each of them entails a MaxI true answer, namely itself.

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External and internal *same*: A unified account motivated by attitude reports[1]

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Abstract. I use empirical evidence from attitude reports to motivate a new characterization of natural language identity relation. More specifically, when *de dicto* attitude reports express an identity relation (e.g., *John thinks A is B*, *John thinks A and B are the same*), felicitous *de re* reports corresponding to them are systematically absent. This finding means that the identity relation encoded in natural language cannot be analyzed as a simple co-reference relation. Instead, I propose that in a given context, the identity relation between A and B means that contextually salient properties of A hold in certain worlds (e.g., in the belief worlds of an attitude holder) for B and vice versa. Based on this, I propose a new unified account for internal and external uses of *same*. Essentially, *same* is anaphoric: its antecedent is a plurality of individuals (i.e., *res*) and *same* means the intersection of contextually salient properties of each atomic individual involved in an identity relation.

Keywords: identity relation, *same*, *be*, attitude reports, *de re*, *de dicto*, Frege's Puzzle.

1. Introduction

As illustrated in (1a) and (1b), (i) *A is B (and B is A)* and (ii) *A and B are the same* are typical natural language schemas for expressing the identity relation between A and B. Traditionally, the identity relation has been analyzed as $\lambda x_e.\lambda y_e.[x = y]$ (see Frege 1892 and recent studies on copula *be* and adjective *same*, e.g., Heim 1985, Solomon 2009, Brasoveanu 2011, Percus and Sharvit 2014, Hardt and Mikkelsen 2015). However, simply using '=' to formally represent the identity relation cannot characterize the human cognitive mechanism underlying the use of these natural language identity expressions, and consequently, leaves Frege's Puzzle unaccounted for. As illustrated in (2), (2a) and (2b) certainly have different cognitive values: while (2a) is a trivially informative tautology, (2b) contains significant astronomical information.

(1)   Expressing the identity relation between Phosphorus and Hesperus in English:

    a.   Phosphorus **is** Hesperus (and Hesperus **is** Phosphorus).

    b.   Phosphorus and Hesperus are the **same**.

(2)   Frege's Puzzle:

    a.   Phosphorus is Phosphorus. $\leadsto$ A tautology

    b.   Phosphorus is Hesperus. $\leadsto$ Not a tautology

Zhang (2016) uses empirical evidence from attitude reports to show that the identity relation in natural language cannot be a co-reference relation. Instead, (3) is proposed to characterize the meaning of natural language identity relation. Based on (3), Zhang (2016) further studies the semantics of **symmetric** *be*. Here I pursue this line of research and focus on *same*.

(3)   The semantics of identity relation in natural language:
        The identity relation between A and B is a **mutual predication**: contextually salient properties coerced from the individual (i.e., *res*) referred to with the expression A hold in contextually relevant worlds for the *res* referred to with the expression B, and vice versa.

The main claim of the current paper is that, essentially, *same* is anaphoric: its antecedent is a plurality of individuals (i.e., *res*) and *same* means the intersection of contextually salient properties of each atomic individual involved in an identity relation.

§2 – §4 briefly summarize Zhang (2016). §2 presents empirical evidence: felicitous *de dicto* reports expressing an identity relation cannot have felicitous *de re* reports corresponding to them. Based on the neo-Russellianism, §3 shows the reasoning that leads to this conclusion: in *de dicto* reports expressing an identity relation, the semantic contribution of the expressions of *res* names cannot be purely extensional. Then §4 analyzes the semantics of symmetric *be*. Based on §2 – §4, §5 presents a new analysis for *same*. §6 further addresses several issues of *same* and gives a unified account for internal *same* and external *same*. §7 concludes the paper and suggests avenues for future research.

2. Empirical evidence: Attitude reports of identity relation

This section is inspired by and based on Percus and Sharvit (2014). Percus and Sharvit (2014) aim to account for the asymmetry of attitude reports in **mistaken identity contexts** (see also Cumming 2008). As illustrated in (4), in a mistaken identity context, such as (4a), the narrator's statement (4b), i.e., *Kevin thinks that Becky is Dan*, is an intuitively true and felicitous attitude report. Moreover, as Cumming (2008) and Percus and Sharvit (2014) point out, in this situation, the narrator Jim can even add *but of course he doesn't think that Dan is Becky*, and intuitively, we still judge what Jim says to be true, felicitous and self-consistent.

(4)   a.   MISTAKEN IDENTITY CONTEXT:
                Peter is throwing a party in honor of his cousin Dan who has just been awarded his PhD. All the guests know that, but they don't all know Dan (and some of them, like Kevin, don't even know the new PhD's name). When Becky arrives, Kevin, who is already completely toasted, walks up to her with a big smile. 'You must be proud to be a doctor now,' he says, 'is your wife coming too?' Seeing this, Jim says to Peter:
        b.   'Kevin thinks that Becky is Dan, (but of course he doesn't think that Dan is Becky).'
                ⤳ A true and felicitous *de re* report

Based on our judgment for (4b), Percus and Sharvit (2014) claim that attitude reports motivate an **asymmetric** use of *be*.[2] Notice that under the given context (4a), the attitude holder Kevin doesn't know the name of the individual who is actually Becky. Thus *Kevin thinks that Becky is Dan* can only be felicitous as a ***de re*** report, but not as a ***de dicto*** report (see Sudo 2014 among many others). The felicity of (4b) indicates that asymmetric *be* can be used in *de re* attitude reports.

Now I present new empirical data showing that (i) attitude reports motivate not only an **asymmetric** *be*, but also a **symmetric** *be*, and (ii) more interestingly, while felicitous *de dicto* reports using asymmetric *be* can have felicitous *de re* reports corresponding to them, felicitous *de dicto* reports expressing an identity relation (via the use of *same* or symmetric *be*) cannot. In the following, (5) presents the common background for (6) and (7), which present two different sub-contexts.

(5)   ANONYMOUS REVIEWING CONTEXT:
         After submitting a paper to a journal, John gets an anonymous review for his paper. The review is actually written by Mary, but of course, John doesn't know this. Mike is an editor of the journal and he knows that Mary is the reviewer.

(6)   SUB-CONTEXT A – PREDICATION CONTEXT:
         Afterwards, when John meets Mike, he tells Mike that he finds the review is very old-fashioned and shows a certain empathy for baldness, and John says: 'I think the author of the review should be a bald man in his 90s.' Mike discloses nothing to John, but later he tells the whole story to another person, Tim:

de dicto reports		corresponding *de re* reports	
a. 'John thinks that the reviewer **is** a bald man in his 90s.'	✓	a′. 'John thinks that Mary **is** a bald man in his 90s.'	✓
b. 'John thinks that a bald man in his 90s **is** the reviewer.'	✗	b′. 'John thinks that a bald man in his 90s **is** Mary.'	✗
c. 'John thinks that the reviewer and a 90-year old bald man are the **same** person.'	✗	c′. 'John thinks that Mary and a 90-year old bald man are the **same** person.'	✗

(7)   SUB-CONTEXT B – IDENTITY CONTEXT:
         Afterwards, John and Mike go to a conference. There John sees a bald man in his 90s talking about John's paper with others. Based on what he sees, John says to Mike: 'The old guy must have reviewed my paper.' Mike discloses nothing to John, but later Mike tells the whole story to another person, Tim:

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[2]In fact, Percus and Sharvit (2014) point out that with a special intonation pattern, the narrator Jim can utter *Kevin thinks that DAN is BECky* to express the same meaning as *Kevin thinks that Becky is Dan* (cf. *A doctor you might consult is John*, see Mikkelsen 2005). Percus and Sharvit (2014) analyze this kind of inversion cases as the result of a focus projection. In this paper, I do not consider this kind of attitude reports that have a focus projection, a special intonation pattern, and an inverse reading.

de dicto reports			corresponding *de re* reports		
a.	'John thinks that the reviewer **is** a bald man in his 90s.'	✓	a′.	'John thinks that Mary **is** a bald man in his 90s.'	✗
b.	'John thinks that a bald man in his 90s **is** the reviewer.'	✓	b′.	'John thinks that a bald man in his 90s **is** Mary.'	✗
c.	'John thinks that the reviewer and a 90-year old bald man are the **same** person.'	✓	c′.	'John thinks that Mary and a 90-year old bald man are the **same** person.'	✗

Obviously, given the common background (5), *the anonymous reviewer* and *Mary* are two co-referring names in both (6) and (7). As (6) shows, under this predication sub-context, (6c) is an infelicitous *de dicto* report, and there is a contrast between the felicity judgment of the two *de dicto* reports (6a) and (6b). These judgments indicate that in the *de dicto* reports (6a) and (6b), copula *be* has an asymmetric reading. The judgment of (6a′) indicates that under this sub-context, the felicitous *de dicto* report (6a) can have a felicitous *de re* report corresponding to it.

In contrast, as (7) shows, under this identity sub-context, (7c) is a felicitous *de dicto* report, and moreover, (7a) and (7b) are both felicitous *de dicto* reports. These judgments indicate that in the *de dicto* reports (7a) and (7b), copula *be* has a symmetric reading, and all these three *de dicto* reports (7a) – (7c) express the attitude holder's view on an identity relation. Intriguingly, under this identity sub-context (7), though the *de dicto* reports (7a) – (7a) are all felicitous, none of them has a felicitous corresponding *de re* report: (7a′) – (7c′) are all intuitively judged to be infelicitous.

Therefore, from the empirical data shown in (6) and (7), we can have the following generalization:

(8)   **Generalization on attitude reports expressing an identity relation**:
        A *de dicto* attitude report expressing an identity relation between *res* has no felicitous *de re* reports corresponding to it.

3. Proposal: The semantics of identity relation

According to the neo-Russellian view of attitude reports, which is shown in (9), the truth and felicity of a *de re* report depends on (i) the truth of its corresponding *de dicto* report and (ii) the co-referring relation between individual (i.e., *res*) names. Notice that from (9), it does not follow that felicitous *de dicto* reports always have felicitous *de re* reports corresponding to them.

(9)   The neo-Russellian view of attitude reports (see McKay and Nelson 2014):
        Felicitous *de re* attitude reports are derived from felicitous *de dicto* attitude reports via the substitution of co-referring *res* names.

In fact, the substitution of co-referring *res* names *salva veritate* has several requirements. First and the most importantly, as Quine (1956) claims, an attitude report can be considered as a relation among three items: (i) an attitude holder X, (ii) a *res* named Y of type e, and (iii) a property P of type $\langle s, et \rangle$, and the relation among them can be phrased as 'the attitude holder X ascribes to the *res* named Y the property P', i.e., P holds for Y in w ($w \in \text{Attitude}(X)$). Crucially, Quine (1956) points out that the substitution of co-referring *res* names *salva veritate* is based on the fact that the semantic contribution of Y is in effect purely **extensional**.[3]

Second, as Kaplan (1969) and Lewis (1979) emphasize, an appropriate *res* for an attitude holder needs to stand in **an acquaintance relation** with the attitude holder so that the *res* becomes **a character in the inner story of the attitude holder**. What this amounts to is that (i) the same real character in the actually world can become different characters in the inner story of an attitude holder (imagine that some people fail to recognize that Dr. Jekyll and Mr. Hyde are the same actual person and consider them to be two characters in their inner story), and (ii) different real characters in the actual world can become one single character in the inner story of an attitude holder, if the attitude holder fails to tell that they are actually different characters.[4]

Third, as Anna Szabolcsi (p.c.) points out, *de re* readings are possible only when there is a narrator who is personally involved in the whole situation, so that (i) the narrator understands what constitutes a *res* for the attitude holder and (ii) the co-reference relation between *res* names holds for the narrator. The substitution of co-referring *res* names is actually done by the narrator.[5] In other words, though a *res* is different from a real character in the actual world, it is an objective being of type e, which is not private to the attitude holder. If *res* were private, interlocutors (e.g., narrators) would not be able to mention and discuss it, and no communication would be possible.

Now let us take a closer look at (6) and (7). The fundamental difference between these two sub-contexts is the number of *res* in the inner story of the attitude holder John. As summarized in the table (10), in the predication sub-context (6), the attitude holder John has access only to **one *res***, namely the author of the review he reads, and he is acquainted with this *res* only through reading the review written by this *res*. In contrast, in the identity sub-context (7), the attitude holder John has access to **two *res***: (i) the author of the review, and (ii) the old man standing before John. John has access to these two *res* through two acquaintance relations: he is acquainted with the *res* 'the author of the review' through knowing that his paper is reviewed by this *res*; in addition, he is acquainted with the *res* 'the bald man in his 90s' through seeing this *res* talking about his paper. The upshot is that in a ***de dicto* report of identity relation**, there are necessarily **more than one *res***, and eventually the attitude holder draws the conclusion that there is an identity relation between these *res*.

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[3]See Sudo (2014) for a more generalized view: the *res* of attitude reports is not necessarily some individual of type e, but can be anything the semantic contribution of which is purely extensional in attitude reports.

[4]SPOILER ALERT: consider how Angier views Alfred Borden in Christopher Nolan's 2006 film *The Prestige*.

[5]As a consequence, what we mean by **reference world** or **actual world** in attitude reports should actually be understood as a world in the set of the narrator's belief worlds.

(10)   Comparing the empirical data shown in (6) and (7):

	Predication sub-context (6)	Identity sub-context (7)
number of *res*	1 (the reviewer)	2 (the reviewer and an old man)
de dicto reports	(6a): predication statement	(7a) – (7c): identity statements
the use of *be*	asymmetric	symmetric
de re reports	available: see (6a′)	unavailable: see (7a′) – (7c′)

Now recall that the substitution of co-referring *res* names *salva veritate* can happen if and only if the semantic contribution of *res* names is purely extensional. Therefore, the failure of substituting co-referring *res* names for *de dicto* reports of identity relation indicates that in these *de dicto* reports, the semantic contribution of the expressions used as *res* names is **not purely extensional**. Thus, following Quine (1956)'s analysis of attitude reports, I propose (3) to characterize the meaning of natural language identity relation: essentially, the identity relation is a mutual predication, i.e., contextually salient properties coerced from each individual involved in an identity relation hold for all the other individuals involved in this identity relation.

Thus, the generalization (8) can be easily accounted for within the neo-Russellian view of attitude reports. In an identity relation, since *res* names contribute both extensionally (as *res* names to refer to individuals) and intensionally (as contextually salient properties), the first requirement for the substitution of co-referring name *salva veritate* cannot be satisfied. As a consequence, no felicitous *de re* report can be derived from felicitous *de dicto* reports expressing an identity relation.

4. Accounting for the symmetric use of copula *be*

Based on §3, I propose (11) and (12) as the semantics of asymmetric *be* and symmetric *be*:

(11)   a. $[\![be_{\text{asymmetric}}]\!]^w_{\langle\langle s,et\rangle,et\rangle} \overset{\text{def}}{=} \lambda P_{\langle s,et\rangle}.\lambda x_e.P(w)(x)$

         b. $[\![be_{\text{asymmetric}}]\!]^w_{\langle e,et\rangle} \overset{\text{def}}{=} \lambda y_e.\lambda x_e.P_{(w,y)}(w)(x)$ $P_{(w,y)}$ is of type $\langle s,et\rangle$.

(12) $[\![be_{\text{symmetric}}]\!]^w_{\langle e,et\rangle} \overset{\text{def}}{=} \lambda y_e.\lambda x_e.P_{(w,y)}(w)(x) \wedge P_{(w,x)}(w)(y)$

(11a) shows that asymmetric *be* relates a property P of type $\langle s,et\rangle$ and an individual x of type e, and the property holds for the individual in a relevant world. (11b) shows that when asymmetric *be* apparently relates two expressions of individual names y and x, one of the expressions (say y) is coerced into and interpreted as some contextually salient property in a certain world w (represented as $P_{(w,y)}$ here), and asymmetric *be* further relates the property $P_{(w,y)}$ and the individual x. For example, in the case of (4b), there is an asymmetry between the two proper names *Becky* and *Dan*: the name *Dan* is coerced into a property, i.e., the contextually unique new PhD. The attitude holder

Kevin has established an acquaintance relation only with one *res*, namely the newly arrived guest, and Kevin ascribes to this individual the property of being the new PhD, i.e., the property of 'being Dan'. Therefore, it follows that Kevin thinks that Becky has the contextually salient property of Dan, i.e., Kevin thinks that Becky is Dan. On the other hand, there is no acquaintance relation between the attitude holder Kevin and the individual Dan. Then it follows naturally that Kevin cannot ascribe any property to this individual, i.e., Kevin cannot ascribe to the individual named Dan the property of being Becky, and thus Kevin doesn't think that Dan is Becky.

As (12) shows, symmetric *be* relates two *res* names y and x (of type e), and there are two contextually salient properties coerced from these two names, i.e., $P_{(w,y)}$ and $P_{(w,x)}$, so that the contextually salient property $P_{(w,y)}$ holds for the *res* named x in the given possible world w, and similarly, the contextually salient property $P_{(w,x)}$ holds for the *res* named y in the given possible word w. Evidently, in (7), two *res*, *the reviewer* and *a bald man in his 90s* are related by a symmetric *be*, and thus both of these names contribute extensionally (as *res* names) and intensionally (as properties). Since their contribution is not purely extensional, it follows necessarily that the generalization in (8) holds and the name *the reviewer* cannot be replaced by *Mary* to derive a *de re* report.

(13) shows Percus and Sharvit (2014)'s analysis of asymmetric *be*: when asymmetric *be* relates two expressions of individual names x and y, a contextually salient type shifter f (of type $\langle e, se \rangle$) takes one individual (say y) as its argument and returns a contextually salient individual concept $f(y)$, and asymmetric *be* further relates $f(y)$ and x. In addition to the use of predication (instead of '='), there is another difference between my lexical entry (11b) and (13): (11b) has no type shifter of type $\langle e, \langle s, et \rangle \rangle$ that turns individuals of type e into properties of $\langle s, et \rangle$.

(13) $[\![\text{be}_{\text{asymmetric}}]\!]^w_{\langle e,et \rangle} \overset{\text{def}}{=} \lambda y_e.\lambda x_e.x = [f_{\langle e,se \rangle}(y)](w)$ Percus and Sharvit (2014) (cf. (11b))

A type shifter is a function, which means that it always returns the same value when taking arguments of the same value. As (14) illustrates, in Sub-context 1 – (14a), it is only the property of being beautiful that is relevant, and here the meaning of $P_{(w \in \text{Dox(Snape)}, \text{Evans})}$ roughly means *as beautiful as Evans*; while in Sub-context 2 – (14b), it is only the property of being intelligent that is relevant, and here the meaning of $P_{(w \in \text{Dox(Snape)}, \text{Evans})}$ roughly means *as intelligent as Evans*. In other words, even though in Snape's belief worlds, Evans always has the properties of being beautiful and being clever, $P_{(w \in \text{Dox(Snape)}, \text{Evans})}$ does not always have the same interpretation.

(14)   BACKGROUND: Snape always thinks that Evans is a beautiful and intelligent woman.
         a. SUB-CONTEXT 1: One day, Snape remotely sees a beautiful woman and thinks that she must be Evans. Having known this, Lupin tells Potter:
         a'. 'Snape thinks that beautiful woman is Evans.'
         b. SUB-CONTEXT 2: One day, Snape sees a very cleverly designed magic potion and thinks that it must be made by Evans. Having known this, Lupin tells Potter:

b′. 'Snape thinks the one who has made the potion is Evans.'

Presumably, the exact meaning of $P_{(\text{possible world, name expression})}$ reflects what property an attitude holder associates with an expression in a certain context and involves a complex cognitive process for the attitude holder in perceiving the name in the context. Thus, the relation between a name expression (say y) and the property coerced from it (say $P_{(w,y)}$) is certainly beyond compositional semantics. It is for this reason that I choose not to use a type shifter to perform this coercion job.

5. The semantics of *Phosphorus and Hesperus are the same*

Here I provide a new analysis of *same*, so as to capture the fact that (1a) and (1b) entail each other. My proposal for the semantics of *same* is shown in (15). As (15) shows, *same* has an adjectival type, i.e., $\langle et \rangle$. The interpretation of *same* requires a plurality of individuals to be its antecedent. Here I use the variable xs to represent this plurality of individuals: xs means a list of entities of type e. A list, e.g., $\boxed{5, 2, 2, ...}$, represents a sequence of values, where (i) values are of the same type and (ii) the order among the items in a list is recorded and thus the same value may occur more than once. If the values of a list are of type α, then the type of the list is $[\alpha]$. Here xs is of type $[e]$. *Same* denotes the intersection of contextually salient properties $P_{(w,x_i)}$ coerced from each element x_i in this plurality xs, i.e., the intersection of $P_{(w,x_i)}(w)$.[6]

(15) $[\![\text{same}]\!]^w_{\langle et \rangle} \overset{\text{def}}{=} \bigcap_{x_i \in xs} P_{(w,x_i)}(w)$
         When the possible world w is omitted, $[\![\text{same}]\!]_{\langle et \rangle} \overset{\text{def}}{=} \bigcap_{x_i \in xs} P_{x_i}$

Following Zhang (2015), I analyze *and* as a list marker, and propose to use a silent operator $\int$ (which essentially means fold) to bridge between a list and the rest part of the semantic derivation of a sentence. As (16) shows, $\int$ takes a list xs of type $[\alpha]$ and returns a partially applied function, so that later when this partially applied function takes an operator argument (e.g., $\wedge$, $\oplus$), the list can be flattened, as (17) illustrates. The use of fold is defined in a recursive way.

(16) $\int_{\langle [\alpha], \langle \langle \alpha, \alpha\alpha \rangle, \alpha \rangle \rangle} \overset{\text{def}}{=} \lambda xs_{[\alpha]}.(\lambda g_{\langle \alpha, \alpha\alpha \rangle}.\text{fold } g \ xs)$, in which
         (i) fold $g \ \boxed{}$ is undefined ($\boxed{}$ is an empty list); (ii) fold $g \ \boxed{x} = x$ ($\boxed{x}$ is a singleton list);
         (iii) fold $g \ (xs \text{ cons } x) = g \ (\text{fold } g \ xs) \ x$
         $(xs \text{ cons } x)$ stands for the resultant list of adding an item x on the right side of a list xs.

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[6]The use of lists in natural language semantics has been independently motivated in Zhang (2015), and a similar view, namely using a multiset in analyzing *same*, has also been proposed in Kubota and Levine (2015). Of course, this plurality of entities can also be written as a **(multi)set** $\{X\}$ or a **sum** X of entities. I choose to use lists in this paper to facilitate the compositional derivation of *Bill and Susan read the same book*, which I will show in §6.2.

(17) $\quad [\![\text{Al and Cal}]\!] = f \,\boxed{\text{Al, Cal}}\, = \lambda g.\text{fold } g \,\boxed{\text{Al, Cal}}$

     a.   When $g = \sqcap$ (and *Al* and *Cal* are of type $\langle et, t\rangle$), $[\![(17)]\!] = \lambda P.[\text{Al}(P) \sqcap \text{Cal}(P)]$

     b.   When $g = \oplus$ (and *Al* and *Cal* are of type e), $[\![(17)]\!] = \text{Al} \oplus \text{Cal}$

(18) shows another operator fmap as well as its definitions for two **type constructors** – list $\boxed{\cdot}$ and function $(\lambda x_{r.\,\ldots})_{r\to}$. A type constructor f (e.g., $\boxed{\cdot}$) takes a concrete **type** (e.g., α) to build a new concrete type (e.g., $[\alpha]$ – a concrete list type). To facilitate reading, I mark the first argument of fmap in red and the second argument of fmap in blue, and here type $\langle \alpha\beta\rangle$ is written as $\alpha \to \beta$. (18c) shows the function f that will be used in the current paper.

(18)   Type of fmap: $(a \to b) \to f\, a \to f\, b$ (f is a type constructor)

     a. f is $\boxed{\cdot}$: fmap $k_{a\to b}\,\boxed{} = \boxed{}$; fmap $k_{a\to b}\,(xs\,\text{cons}\,x)_{[\alpha]} = (\text{fmap}\,k\,xs)\,\text{cons}\,(k\,x)$

     b. f is $(\lambda x_{r.\,\ldots})_{r\to}$: fmap $k_{a\to b}\,g_{r\to a} = \lambda x_r.k(g(x))$

     c.   When f is a composition of $\lambda g.\text{fold } g\ldots$ and $\boxed{\cdot}$, $f = \lambda g.\text{fold } g\,\boxed{\cdot}$.

Based on (15), (16) and (18), (19) shows the derivation of (1b):

(19)   a. $[\![\text{Phosphorus and Hesperus}]\!] = \lambda g.\text{fold } g\,\boxed{\text{Phosphorus, Hesperus}}$

     b. $\because$ Here $xs = \boxed{\text{Phosphorus, Hesperus}}$,   (see (15))

            $\therefore [\![\text{same}]\!] = P_{\text{Phosphorus}} \sqcap P_{\text{Hesperus}} = \lambda x.[P_{\text{Phosphorus}}(x) \wedge P_{\text{Hesperus}}(x)]$

     c.   Assume here the contribution of *the* is vacuous,[7] and the use of *be* is asymmetric, $[\![\text{Phosphorus and Hesperus are the same}]\!]$

            $\Leftrightarrow$ fmap $[\![\text{be the same}]\!]\,[\![\text{Phosphorus and Hesperus}]\!]$

            $\Leftrightarrow$ fmap $\lambda x.[P_{\text{Phosphorus}}(x) \wedge P_{\text{Hesperus}}(x)]\,\lambda g.\text{fold } g\,\boxed{\text{Phosphorus, Hesperus}}$

            $\Leftrightarrow \lambda g.\text{fold } g\,\boxed{\lambda x.[P_{\text{Ph}}(x) \wedge P_{\text{He}}(x)](\text{Ph}), \lambda x.[P_{\text{Ph}}(x) \wedge P_{\text{He}}(x)](\text{He})}$

     d.   When $g = \wedge$, this is equivalent to $P_{\text{Phosphorus}}(\text{Phosphorus}) \wedge P_{\text{Hesperus}}(\text{Phosphorus})$ $\wedge P_{\text{Phosphorus}}(\text{Hesperus}) \wedge P_{\text{Hesperus}}(\text{Hesperus})$.

            Since $P_{\text{Phosphorus}}(\text{Phosphorus})$ and $P_{\text{Hesperus}}(\text{Hesperus})$ are tautologies, this is equivalent to $P_{\text{Hesperus}}(\text{Phosphorus}) \wedge P_{\text{Phosphorus}}(\text{Hesperus})$, which is a mutual predication.

            $\therefore [\![(1a)]\!] = [\![(1b)]\!] = P_{\text{Hesperus}}(\text{Phosphorus}) \wedge P_{\text{Phosphorus}}(\text{Hesperus})$

As shown in the last line of (19), the current analysis of *same* accounts for the mutual entailment between (1a) and (1b). Moreover, when these two sentences (1a) and (1b) are embedded in attitude reports, individual names *Phosphorus* and *Hesperus* will contribute both extensionally as names and intensionally as properties (i.e., $P_{(w,\text{Phosphorus})}$ and $P_{(w,\text{Hesperus})}$), thus it follows that *de dicto* reports containing this kind of identity statements have no corresponding *de re* reports.

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[7]I will further discuss this issue in §6.5.

Finally, the current analysis can also account for Frege's Puzzle in a very natural way. Since the identity relation in natural language is not a co-reference relation, it follows that stating an identity relation between expressions A and A is different from stating an identity relation between A and B: the former is a tautology, while the later is a mutual predication and provides new information.

6. A unified semantics of internal *same* and external *same*

In §5, I have proposed a new analysis of *same* which accounts for (i) the mutual entailment relation between (1a) *Phosphorus is Hesperus (and Hesperus is Phosphorus)* and (1b) *Phosphorus and Hesperus are the same*, (ii) the fact that *de dicto* attitude reports expressing an identity relation lack corresponding *de re* reports (i.e., the generalization in (8)), as well as (iii) Frege's Puzzle (see (2)). In this section, I further extend my analysis to give a unified analysis of internal and external *same*, and account for some other behaviors of *same*.

As (20) illustrates, in (20a), the felicitous use of external *same* requires the existence of a contextually salient book prior to the utterance of *Susan read the same book*, and evidently, in this case, this requirement is satisfied – it is *War and Peace*, a book also read by Bill. In contrast, in (20b), the use of internal *same* does not have this requirement, and essentially *the same book* here means a book commonly read by both Bill and Susan.

(20)   a.   Bill read *War and Peace*. Susan read the **same** book.   External *same*
          b.   Bill and Susan read the **same** book.   Internal *same*

I start with a discussion of Heim (1985) and the presuppositional requirement of *same* in §6.1. Then §6.2 presents my account for internal *same* and external *same*. Afterwards, I address three issues on *same* that have been much debated in previous literature: its scope taking behavior (§6.3), its island effects (§6.4) as well as the obligatory use of *the* in using *same* (§6.5).

6.1. The presuppositional requirement of *same*

According to Heim (1985), *same* sentences require the interpretative convention shown in (21):

(21)   'same $\langle A \rangle f$' is true iff for all x, y in A: $f(x) = f(y)$.   (Heim 1985)

Thus, under Heim (1985)'s analysis, the sentence (20b) (repeated here as (22a)) should be interpreted in the way (22b) shows. Heim (1985)'s analysis is certainly consistent with our intuition for *same* sentences. It is also consistent with the current analysis: the only difference is that the current analysis further specifies the meaning of the identity relation between $f(x)$ and $f(y)$.

(22)   a.   Bill and Susan read the same book.   (20b)
        b.   Heim (1985)'s analysis: the book that Bill read = the book that Susan read
              i.e., The book that Bill read and the book that Susan read are the same.

As a consequence, Heim (1985)'s analysis suggests that *same* brings a presuppositional require-
ment: for each of the individuals x and y, there is a contextually unique or most salient $f(x)/f(y)$
corresponding to it. Evidently, only when $f(x)$ and $f(y)$ exist and are contextually definite (or
salient) individuals can we further judge whether there is an identity relation between them. Es-
sentially, this is also consistent with the current analysis: *same* is anaphoric and requires a plurality
of contextually salient items to be its antecedent.

(23)   The presuppositional requirement of *same*:
        Same requires the existence of a plurality of **contextually salient / unique** individuals.

(24) – (27) provide further evidence: intuitively, the two sentences in each pair have the same
meaning, and all these sentences presuppose that there is a definite unicorn such that John saw it
and that there is a definite unicorn such that Bill saw it. Thus (24) – (27) show that the presuppo-
sitional requirement (23) does project in negation, questions and modal contexts.

(24)   a.   John and Bill saw the same unicorn.
        b.   The unicorn John saw and the unicorn Bill saw are the same.

(25)   a.   John and Bill didn't see the same unicorn.   Negation
        b.   The unicorn John saw and the unicorn Bill saw are not the same.

(26)   a.   Did John and Bill see the same unicorn?   Question
        b.   Are the unicorn John saw and the unicorn Bill saw the same?

(27)   a.   John and Bill might have seen the same unicorn.   Modal context
        b.   The unicorn John saw and the unicorn Bill saw might be the same.

6.1.1. Is eventuality a necessary ingredient in the semantics of *same*?

According to Hardt and Mikkelsen (2015), eventuality is a necessary ingredient in the semantics
of *same*. Their crucial evidence is illustrated in (28). The contrast between (28a) and (28b) shows
that simply introducing an individual (here the book *War and Peace*) into a discourse can license
the use of a pronoun (here *it*), but it is not sufficient for licensing the use of external *same*.

(28)   Bill didn't read *War and Peace*,

     a.   *but Susan read the same book.

     b.   but Susan read it.

To account for (28), Hardt and Mikkelsen (2015) adopt Kehler (2002)'s Parallel (see (29)) and propose that the felicitous use of *same* has to be based on a parallelism between events (see (30)).

(29)   Kehler (2002)'s Parallel:
     Infer $P(a_1, a_2, ...)$ from the assertion of $S1$ and $P(b_1, b_2, ...)$ from the assertion of $S2$, for a (non-trivial) common P and similar a_i and b_i.

(30) $e_1 : R_1(a_1, ..., a_n) \land e_2 : R_2(b_1, ..., b_m) \land \mathbf{parallel}(e_1, e_2)$
     $\Rightarrow \mathrm{Parallel}(R_1(a_1, ..., a_n), R_2(b_1, ..., b_m))$

In Hardt and Mikkelsen (2015)'s analysis, *same* must compare two eventualities. However, in (28), the event 'Bill read *War and Peace*' is embedded under negation and thus cannot be an accessible discourse referent (dref) for subsequent discourse. Therefore, there is no event that is parallel with the event 'Susan read the same book', and this accounts for the weirdness of (28a).

Here I argue that the lack of parallelism between eventualities cannot be a satisfactory account for the weirdness of (28a). Instead, the weirdness of (28a) should be related to the presuppositional requirement of *same*. First, notice that while (28a) is weird, (31) is a good sentence, no matter whether *didn't* is inserted or not. This indicates that when the presuppositional requirement of *same* is satisfied, even though *the book that Bill didn't read* contains a negation and there is no event parallelism between *Bill didn't read a certain book* and *Susan read a certain book*, it is still felicitous to compare the two individuals 'the book Bill didn't read' and 'the book Susan read'. (31) suggests that eventuality parallelism is not necessary in licensing the use of *same*. Second, as (32) illustrates, when there are two books that are equally salient in the context, the use of *same* is infelicitous. This indicates that when the presuppositional requirement of *same* is not satisfied, even though the event 'Bill read Emma / Madame Bovary' can be an accessible event dref for subsequent discourse and in parallel with the event 'Susan read the same book', *same* cannot be used. (32) suggests that eventuality parallelism is not sufficient in licensing the use of *same*.

(31)   The book that Bill didn't read and the book that Susan (didn't) read are the same.

(32)   Bill read *Emma* and *Madame Bovary*. *Susan read the same book.

Presumably, though both a positive sentence such as *Bill read Emma* and a negative sentence such as *Bill didn't read Emma* can introduce *Emma* as a dref, these two instances of *Emma* have different contextual salience. For the negative sentence *Bill didn't read Emma*, it is less natural to assume that *Emma* is the contextually unique (or most salient) book that Bill didn't read, which makes it harder to satisfy the presuppositional requirement of *same*. A full investigation of this issue certainly needs experimental data and is left for future research.

6.1.2. Why *Everyone has the same friend* sounds weird?

(33a) illustrates another relevant issue discussed in Hardt and Mikkelsen (2015): Simon Charlow points out that (33a) is a weird sentence. To account for its weirdness, Hardt and Mikkelsen (2015) claim that *friend* is a relational noun, and relational nouns require indefinites or other weak quantifiers (see (33b)). However, as naturally occurring examples (34) and (35) illustrate, *the same* can be compatible with relational nouns (e.g., *age, birthday*).

(33)   a. #Everyone has the same friend.
        b.   Everyone has a friend.

(34)   Q5 presented them with a purported induction proof that in any finite group of Americans, **everyone has the same age** (and hence all Americans have the same age).
        http://mooctalk.org/2014/11/29/do-all-americans-have-the-same-age/

(35)   ... when **everyone has the same birthday** ...
        https://prezi.com/lx06svu6xldn/chance-of-the-same-birthday/

Under the current analysis, this difference between *friend* and *age/birthday* can be easily accounted for by the presuppositional requirement of *same*. It is pragmatically weird to assume that each individual has only one unique friend, but for each individual, there is a unique age and a unique birthday corresponding to him or her. Consequently, while (34) and (35) can satisfy the presuppositional requirement of *same*, (33a) cannot, which explains the weirdness of this sentence.

6.2. Internal *same* and external *same*

Having shown the presuppositional requirement of *same*, here I give a unified compositional account for sentences containing internal *same* and external *same*. As Heim (1985)'s interpretation convention (21) suggests, the crucial point is to derive the list $\boxed{f(x), f(y), ...}$ from the list $\boxed{x, y, ...}$. With the use of fmap (see (18)), this can be easily done for the case of (20b):

(36)   ⟦Bill and Susan read the same book⟧   (20b)

     a. $⟦\text{read}⟧_{⟨e,et⟩} \overset{\text{def}}{=} \lambda z.\lambda x.\text{read}(z)(x)$ $\rightsquigarrow x \text{ read } z$

           $⟦\text{Bill and Susan}⟧ = \lambda g.\text{fold } g \boxed{\text{Bill, Susan}}$

     b. $\text{fmap } \lambda x.\text{read}(h(1))(x) \; \lambda g.\text{fold } g \boxed{\text{Bill, Susan}}$

           $= \lambda g.\text{fold } g \boxed{\text{read}(h(1))(\text{Bill}), \text{read}(h(1))(\text{Susan})}$

     c. $\text{fmap } 1 \; \lambda g.\text{fold } g \boxed{\text{read}(h(1))(\text{Bill}), \text{read}(h(1))(\text{Susan})}$

           $= \lambda g.\text{fold } g \boxed{\lambda z.\text{read}(z)(\text{Bill}), \lambda z.\text{read}(z)(\text{Susan})}$ $\rightsquigarrow$ lambda abstraction

     d. $\text{fmap } ⟦\text{the}⟧ \; \lambda g.\text{fold } g \boxed{\lambda z.\text{read}(z)(\text{Bill}), \lambda z.\text{read}(z)(\text{Susan})}$ $\rightsquigarrow$ a silent ⟦the⟧

           $= \lambda g.\text{fold } g \boxed{\iota z.\text{read}(z)(\text{Bill}), \iota z.\text{read}(z)(\text{Susan})}$ $\rightsquigarrow$ the presupposition of *same*

     e. $⟦\text{same}⟧_{⟨et⟩} \overset{\text{def}}{=} \bigcap_{x_i \in xs} P_{x_i}$

           $\because xs = \boxed{\iota z.\text{read}(z)(\text{Bill}), \iota z.\text{read}(z)(\text{Susan})}$

           $\therefore ⟦\text{same}⟧ = \lambda z.[\text{read}(z)(\text{Bill}) \wedge \text{read}(z)(\text{Susan})]$

           $⟦\text{the same book}⟧ = \lambda z.[\text{read}(z)(\text{Bill}) \wedge \text{read}(z)(\text{Susan}) \wedge \text{book}(z)]$

     f.   ⟦Bill and Susan read the same book⟧

           $\Leftrightarrow \text{fmap } ⟦\text{the same book}⟧ \; \lambda g.\text{fold } g \boxed{\iota z.\text{read}(z)(\text{Bill}), \iota z.\text{read}(z)(\text{Susan})}$

           When $g = \wedge$, this is equivalent to

           $[\lambda z.\text{read}(z)(\text{Bill}) \wedge \text{read}(z)(\text{Susan}) \wedge \text{book}(z)](\iota z.\text{read}(z)(\text{Bill}))$

           $\wedge [\lambda z.\text{read}(z)(\text{Bill}) \wedge \text{read}(z)(\text{Susan}) \wedge \text{book}(z)](\iota z.\text{read}(z)](\text{Susan}))$

           I.e., the contextually salient thing that Bill read has the properties of being a book and being read by Susan, while the contextually salient thing that Susan read has the properties of being a book and being read by Bill.

Right Node Raising cases can also be easily derived in the current analysis:

(37)   ⟦Bill read and Susan reviewed the same paper⟧

     a. $⟦\text{Bill read}⟧ = \iota z.\text{read}(z)(\text{Bill}), ⟦\text{Susan reviewed}⟧ = \iota z.\text{reviewed}(z)(\text{Susan})$

     b. $⟦\text{Bill read and Susan reviewed}⟧ = \lambda g.\text{fold } g \boxed{\iota z.\text{read}(z)(\text{Bill}), \iota z.\text{reviewed}(z)(\text{Susan})}$

     c. $\because xs = \boxed{\iota z.\text{read}(z)(\text{Bill}), \iota z.\text{reviewed}(z)(\text{Susan})}$

           $\therefore ⟦\text{same}⟧ = \lambda z.[\text{read}(z)(\text{Bill}) \wedge \text{reviewed}(z)(\text{Susan})]$

           $⟦\text{the same paper}⟧ = \lambda z.[\text{read}(z)(\text{Bill}) \wedge \text{reviewed}(z)(\text{Susan}) \wedge \text{paper}(z)]$

     d.   ⟦Bill read and Susan reviewed the same paper⟧

           $\Leftrightarrow \text{fmap } ⟦\text{the same paper}⟧ \; \lambda g.\text{fold } g \boxed{\iota z.\text{read}(z)(\text{Bill}), \iota z.\text{reviewed}(z)(\text{Susan})}$

           When $g = \wedge$, this is equivalent to

           $[\lambda z.\text{read}(z)(\text{Bill}) \wedge \text{reviewed}(z)(\text{Susan}) \wedge \text{paper}(z)](\iota z.\text{read}(z)(\text{Bill}))$

           $\wedge [\lambda z.\text{read}(z)(\text{Bill}) \wedge \text{reviewed}(z)(\text{Susan}) \wedge \text{paper}(z)](\iota z.\text{reviewed}(z)](\text{Susan}))$

           I.e., the contextually salient thing that Bill read has the properties of being a paper and

being reviewed by Susan, while the contextually salient thing that Susan reviewed has the properties of being a paper and being read by Bill.

Having shown how to derive the list $\boxed{f(x), f(y), ...}$ from the list $\boxed{x, y, ...}$, now I show how to interpret DPs such as *the boys*, *two boys* and *every boy* as lists of atomic boys. As illustrated in (38), these DPs all license the use of internal *same*.

(38)	a.	<u>The boys</u> read the same book.	✓ internal *same*
	b.	<u>Two boys</u> read the same book.	✓ internal *same*
	c.	<u>Every boy</u> read the same book.	✓ internal *same*

(39) $[\![\text{the}]\!] \overset{\text{def}}{=} \lambda P.[\lambda g.\text{fold } g \boxed{x_i \ | P(\oplus x_i)}_{\text{contextually-salient}}]$
         $[\![\text{the boys}]\!]$ is interpreted as the contextually salient list of boys.

(40) $f_{\text{list-choice}} \overset{\text{def}}{=} \lambda P.[\lambda g.\text{fold } g \boxed{x_i \ |\text{Atom}(x_i) \wedge P(\oplus x_i)}_{\text{choice}}]$
         $[\![\text{two boys}]\!] = \lambda X.[|X| = 2 \wedge \text{boys}(X)]$
         $f_{\text{list-choice}}[\![\text{two boys}]\!]$ is interpreted as a certain list of boys and the length of the list is 2.

(41) $[\![\text{every}]\!] \overset{\text{def}}{=} \lambda P.[\lambda g.\text{fold } g \boxed{x_i \ |\text{Atom}(x_i) \wedge P(x_i)}_{\text{contextually-largest}}]$
         $[\![\text{every boy}]\!]$ is interpreted as the contextually largest boy list, which contains all the boys.[8]

Given the definitions in (39) – (41), *the boys*, *two boys* and *every boy* can be interpreted as lists.[9] Notice that the usual interpretation of these DPs can be easily recovered from these lexical entries: in the cases of *the boys* and *two boys*, when $g = \oplus$, the sum reading of these DPs can be derived. For distributive reading sentences, fmap takes the job of building lists of larger constructions from lists of smaller units, and at the end, $g = \wedge$, making the whole list into a series of conjunctions.

Essentially, external *same* sentences such as (20a) can be analyzed in a very similar way. The only difference is that while for internal *same* readings, all the items involved in an identity relation are expressed within one and the same sentence, for external *same* readings, some items are from the context or previous utterances. In other words, for the external use of *same*, the antecedent of *same*, i.e., a list of individuals, needs to be accommodated from contexts.

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[8]This treatment of the universal quantifier is similar to the analysis of Bumford (2015). The difference is that his analysis aims to account for the use of internal *different* (e.g., *every boy read a different book*): since the book one boy read determines what *different books* can mean for other boys, in Bumford (2015)'s analysis, the universal quantifier works in a sequential way in adding elements into a list. However, in the current analysis, which aims to account for internal *same*, whether element are added into a list sequentially or simultaneously makes no empirical difference.

[9]An additional requirement in licensing internal *same*: in (39) – (41), the length of lists should be at least 2.

6.3. The scope-taking behavior of *same*

According to Barker (2007), internal *same* is a scope-taking adjective: it follows its licenser in taking scope, and therefore, the scope of internal *same* is called 'parasitic scope'. As (42) illustrates, this sentence has two readings: (i) everyone > a group of three men; (ii) a group of three men > everyone. For each reading, the scope of *same* depends on the scope of its licenser, i.e., *three men*.

(42)   Everyone met three men with the same name.
   a.   There is a certain group composed of three men the names of which are the same, and everyone met this group of men.
   b.   Everyone is paired with a certain group composed of three men the names of which are the same, and everyone met the group paired with him or her.

In the current analysis, *same* is anaphoric, and thus it follows necessarily that the scope taking behavior of internal *same* would be similar to that of reflective pronouns (consider *Everyone wants a man$_i$ to recognitive himself$_i$*), i.e., internal *same* takes scope after its antecedent.

There is a difference between Barker (2007) and the current analysis. In Barker (2007), for the sentence (20b), the licenser of internal *same* is *Bill and Susan*, but in my analysis, the antecedent for *same* is 'the thing Bill read and the thing Susan read'. However, as (36) shows, this antecedent is built on the base of the coordination phrase *Bill and Susan*. Thus, empirically the current analysis and Barker (2007) are totally consistent on the scope taking behavior of internal *same*.

6.4. The island effects of *same*

As Carlson (1987) first points out, for internal *same*, 'the licensing NP must appear within the same scope domain as the dependent expression' (see (43)). In the current analysis, these island effects can be accounted for immediately. As shown in the derivation (36), the lambda abstraction in (36c) is essentially a wh-movement, which is subject to island constraints.

Notice that in the current analysis, this lambda abstraction is a crucial step for deriving a plurality (i.e., list) of contextually unique or most salient individuals that serve as the antecedent of *same*. In other words, the insertion of silent ⟦the⟧ in (36d) can be considered as a requirement of *same* (i.e., its presuppositional requirement), and this insertion in turn requires the lambda abstraction in (36c), thus the island effects are actually a necessary consequence of the semantics of *same*.

(43)   a. *Everyone knows why Mary read the same book.   *wh*-island
         b. *Everyone rejected the claim that Mary read the same book.   complex NP island

c.   *Everyone laughs when Mary reads the same book.   adjunct island

6.5. Why is it obligatory to use *the* before *same*?

So far, I have been treating the contribution of *the* before *same* as semantically vacuous. Here I propose that the use of *the* makes the interpretation of *same* as contextually salient as possible.

Notice that in the discussion in §3, the identity relation is essentially characterized as a mutual predication: i.e., for two things involved in an identity relation A and B, contextually salient properties of A (say P_A) hold for B and vice versa. However, if $P_A \sqcap P_B$ hold for both A and B, then for any P'_A such that $P_A \subset P'_A$ and any P'_B such that $P_B \subset P'_B$, it certainly follows that $P'_A \sqcap P'_B$ hold for both A and B. In fact, sentences such as *A and B are the same* can be interpreted in many ways, depending on context: A and B are exactly the same token; A and B are of the same kind; A and B can be two different copies of the same book; A and B can be the same car model but of different colors, etc.

Therefore, if we analyze *same* as the intersection of contextually salient properties of A and contextually salient properties of B, a large number of resultant properties can be qualified as *same*. Thus, the semantic contribution of *the* is probably to pick out the contextually most salient property from this large set of properties. In other words, *the* contributes contextual salience. This use of *the* is actually reminiscent of the use of *the* in superlatives: any height that is larger than the height of the second tallest thing can be considered as tallest, and *the* can be considered as an operator that picks out the most salient height from this set of heights $\{h_i | h_i > h_{\text{the second tallest}}\}$.

7. Summary and outlook

In this paper, based on empirical evidence from attitude reports, I provide a new characterization for natural language identity relation: it is essentially a mutual predication. Based on this, I propose a new analysis for adjective *same*: *same* is anaphoric and it denotes an intersection of contextually salient properties coerced from each atomic individual involved in an identity relation.

There are a few open questions. How is *different* used in attitude reports? How does *same* interact with negation? Besides, can this new characterization of identity relation shed light on the study of *de se* attitude reports as well as reflexive pronouns? I leave these questions for future research.

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