Definites, domain restriction, and discourse structure in online processing

Florian Schwarz

Abstract Definite descriptions are commonly assumed to involve a uniqueness requirement, which is crucially constrained by contextual domain restriction. Theoretical proposals differ with regards to whether a variable for domain restriction should be represented in the linguistic representation or not, and if so, whether it should be seen as contributing a property or a situation. From the perspective of actual language use and comprehension, a key question is just how contextual information is integrated for purposes of domain restriction. Two visual world eye tracking studies addressing these issues are presented. They look at participants' eye movements as they visually inspect an array of colored shapes and listen to descriptions thereof. For example, 'The circle is black' is evaluated relative to a display that contains two circles in different colors and positions. This is preceded by a context sentence that helps to set up a domain that narrows the referential choice to varying degrees, e.g. by containing 'on the top.' Various measures are used to assess to what extent the circle that happens to be at the top is taken to be the referent of the definite description, both in real time online while the sentence unfolds and in terms of ultimate response behavior. The results suggest that people are very much sensitive to the subtle contextual clues, and in particular that the discourse status of the key prepositional phrase in the discourse context is crucial. This has implications for theoretical perspectives on domain restriction, based on their capability to incorporate the role of discourse structure.

1 Introduction

The content of linguistic utterances is commonly evaluated relative to a restricted domain of entities: when we say *Everyone was at the party*, we generally don't

Florian Schwarz

Department of Linguistics, University of Pennsylvania, 3401-C Walnut Street, Suite 300, Philadelphia, PA 19104, USA e-mail: `florians@ling.upenn.edu`

mean, well, EVERYONE. At least since Westerstahl (1984), it is furthermore well-known that the entities constituting the relevant domain can vary for individual noun phrases within one sentence. Assume the following is uttered in a context where we are discussing Sweden:

(1) Most people really dislike foreign tennis players.
   (von Fintel, 1994, modeled after an example from Westerstahl 1984)

The noun phrase *most people* here is plausibly construed as ranging over Swedes, but the noun phrase *foreign tennis players* of course only can make a sensible contribution to the sentence if non-Swedes are considered. Thus, any account of domain restriction phenomena must be able to operate at the level of modulating domains at the level of individual noun phrases (and presumably other phrases, as domain restriction also is at play in, e.g., adverbial quantification).

Domain restriction is also commonly invoked by accounts of definite descriptions (e.g., *the circle*), in particular by those based on a uniqueness condition, such that definites refer to the entity that is unique in the contextual domain in exhibiting the property contributed by the nominal predicate. As Neale (1990) first laid out in fully explicit terms, it is natural, and theoretically parsimonious, to assume that the same mechanism is at play for quantificational and definite noun phrases. The notion that domains can differ across noun phrases within one sentence also helps to deal with well-known puzzles for uniqueness accounts, such as the following, where unique reference of *the dog* can be resolved despite the mention of other dogs:

(2) Yesterday the dog got into a fight with a dog. The dogs were snarling at each other for half an hour, I'll have to see to it that the dog doesn't get near that dog again.

(McCawley, 1979)

Similarly, in a visual display containing shapes in multiple rows, with a circle in both the top and bottom row (as in our experimental displays discussed in more detail below), information in the discourse context can indicate a domain relative to which uniqueness is ensured for a given definite:

(3) I'm looking at the top row of the display. The circle is black.

While there are various detailed theoretical proposals for integrating contextual domains into the computation of sentence meanings, relatively little is known about how and when contextual domains are decided on in online language comprehension. The present set of experiments investigates the online processing of sentences such as *The circle is black* relative to simple visual contexts, which may contain more than one circle, and variations of preceding linguistic contexts that introduce options for choosing a specific restricted domain in interpreting the target sentence. The results indicate that domain restriction choices are made rapidly online, and are modulated by the discourse structure of the preceding context, which supports theoretical accounts that can integrate effects of discourse structure on domain restriction.

The paper is organized as follows: the remainder of this section briefly introduces different theoretical perspectives on domain restriction, and sets the stage by considering related questions from the perspective of semantic and pragmatic processing. The following section presents results from two experimental studies exploring the effects of various contextual manipulations on the online comprehension processes involved in domain restriction. The final section discusses the experimental findings in the broader theoretical context and concludes.

1.1 Theories of Domain Restriction

Broadly speaking, we can differentiate two types of theoretical approaches to capturing domain restriction. One crucially posits silent material in the linguistic representation, which serves as a place-holder where contextual information can be inserted. The other is purely pragmatic, in that it captures the influence of contextual information in a way that is independent of the linguistic representation. I briefly sketch core features of both perspectives below.

Representational approaches can be further differentiated along two additional dimensions. The first concerns the nature of the silent material they posit. C-variable accounts assume that noun phrases contain a variable over predicates (type $\langle e,t \rangle$ in an extensional semantics), whose value is provided by the context, much in the same way a personal pronoun can get its value, e.g., via an assignment function on the interpretation function (von Fintel, 1994; Stanley & Szabo, 2000). The corresponding predicate gets intersected with the nominal predicate, such that, e.g., *most people$_C$* in (1) winds up being restricted to quantifying over people that are Swedes, assuming $C = \{x|\ x$ is a Swede$\}$. Parallel considerations apply in the case of definites, e.g., in (3), the context provides the option of letting $C = \{x|\ x$ is on the top$\}$, thus ensuring unique reference to the circle in that row, despite the presence of another circle elsewhere in the display.

Another type of representational approach posits silent material of another sort, which contributes a situation. Situations are construed as parts of possible worlds, and therefore can be associated with a restricted set of entities that are contained in the situation relative to which an expression is evaluated (Elbourne, 2013; Kratzer, 2007; Schwarz, 2009).[1] Sentences as a whole are evaluated relative to situations (Barwise & Etchemendy, 1987, discuss this in terms of Austinian topic situations), but individual noun phrases can also be independently interpreted relative to potentially different resource situations, providing the necessary flexibility for fixing domains relative to individual noun phrases. Determining the value of individual situation variables is again largely parallel in conceptual terms to fixing the values of pronouns. However, one extension of this type of proposal provides an option that will be crucial for the discussion below, namely to use the contextually salient Question Under Discussion, or QUD (Roberts, 1996), to determine the situation of

---

[1] For early experimental work relevant to the situation semantic approach, see Evans (2005).

evaluation (Kratzer, 2007; Schwarz, 2009). Applying this proposal to the basic example above is largely parallel to the *C*-variable account: in the case of (1), the noun phrase *most people* is evaluated relative to a situation containing Sweden, and in the case of (3), *the circle* can be interpreted relative to a situation containing only the top row of the display.

The second dimension concerns the level of representation at which domain restriction variables are introduced: one option is that they enter the semantic representation as part of the lexical entry of the relevant expressions (most plausibly determiners); alternatively, they can be independently introduced in the syntax, in the form of a silent pronoun that occupies its own syntactic node within the noun phrase.[2] This distinction is largely orthogonal to the discussion of the experimental results below, and I will group these two together under the label of 'representational' approaches.[3] However, note that syntactic accounts offer a straightforward analysis of cases where the domain of a given noun phrase seems to co-vary with a higher quantifier (von Fintel, 1994):

(4)　a.　Every student answered every question about domain restriction.

　　　b.　Every student answered the question about domain restriction.

Both of these sentences have readings where different students were presented with different questions about domain restriction, roughly paraphrasable as 'Every student x answered the/every question about domain restriction that x was asked.' In other words, the universal and definite object noun phrases are evaluated relative to different domains based on which value for the higher quantifier is considered. Syntactic accounts can capture this as standard cases of binding of syntactically represented pronouns (by either letting *C*-variables be complex, allowing for relational values plus an individual variable, or by letting quantifiers like *every student* quantify directly over situations). While the details ultimately hinge on the assumptions of a given framework with regards to covariation and binding, this is commonly seen as an argument in favor of syntactic representational accounts.

A second class of domain restriction accounts denies the presence of domain restriction variables in the linguistic representation, and instead sees the process of domain restriction as a purely pragmatic one (Bach, 1994; Neale, 2004).[4] On these views, consideration of a restricted domain is not directly reflected in the proposition

---

[2] Note that the precise syntactic position of these variables is a matter of disagreement: for syntactic *C*-variable accounts, von Fintel (1994) and Martí (2003) argue for introducing it at the level of the determiner, whereas Stanley and Szabo (2000) propose that it is introduced as a sister to the noun. For situation pronoun accounts, Kratzer (2004), von Fintel and Heim (2007), and Keshet (2010) assume that situation pronouns appear inside of the NP, while Büring (2004), Keshet (2008), and Schwarz (2012) introduce them with (certain) determiners. This will not concern us for present purposes, and the semantic effect of intersecting its value with the nominal predicate is the same on both accounts.

[3] Thanks to Angelika Kratzer for pointing out that labeling these accounts 'syntactic', as I did in earlier versions of this work, misleadingly suggests that the results speak to the question of whether or not domain restriction variables need to be syntactically represented or not.

[4] Note that this is not the only type of 'pragmatic' account in the literature. In particular, Recanati (1996) spells out an account based on Austinian topic situations that he characterizes as

expressed by the linguistic form itself. Rather, a restricted interpretation is derived pragmatically, e.g., in terms of a hearer reconstructing what more explicit sentence the speaker could have uttered to express what they are likely to have meant in context (e.g., *The circle on the top is black.*), given that the literal meaning is obviously false or uninterpretable. Incorporating cases of co-varying domains such as those in (4) may require a view of variable binding that is, at least from the view of formal semantics within linguistics, in some ways non-standard, but is not impossible, as the alternative explicit forms a hearer may consider could include, say, a bound pronoun (Neale, 2004).

A brief note on terminology: while I will use the labels 'representational' vs. 'pragmatic' for the two classes of accounts above, it is clear that domain restriction is inherently a pragmatic phenomenon. The labels merely allude to whether the relevant pragmatic information does or does not get represented directly in the linguistic structure, by positing a suitable variable in the linguistic representation as a slot where that information can be integrated. Also note that the added bit of structure in syntactic accounts on its own does not directly give rise to any predictions about additional processing efforts due to 'adding' that structure in parsing, since on those accounts, it would be posited to be a standard ingredient of any determiner phrase. What will be more directly relevant to our discussion below is that different ways of going about choosing a value for that variable and making use of contextual information in doing so may lead to variation in processing costs.

1.2 Domain Restriction in Processing

While differentiating the above accounts in purely theoretical terms can be a fairly subtle affair, it is worth considering how they relate to questions about the actual processes involved in language comprehension. The most general question is, of course, what factors are involved in determining the value for a given restricted domain. On the representational accounts, the basic mechanism is parallel to the one required for resolving reference of personal pronouns, and the null hypothesis therefore would seem to be that similar contextual factors will be at play. In particular, in choosing a value for pronouns, entities of the right sort that are salient in the context will generally be top contenders, and having a preceding linguistic expression that can serve as an antecedent will be one prominent way of ensuring such salience. (Additional factors will come into play when a choice between multiple sufficiently salient entities has to be made, but that will not concern us here.)

Another set of factors that plausibly could be at play in resolving domain restriction relates to the general scope of the linguistic exchange in question, as well as the

---

'primary pragmatic', contrasting it with Bach's 'secondary pragmatic', or 'Gricean' account'; my discussion focuses on the latter type for presentational purposes, but the experimental results seem largely compatible with Recanati's non-representational, situation-based account, in particular with regards to the need for integrating discourse structure via QUDs, although more would have to be said about how it might link up to questions of processing time-course.

specific goals and plans shared by the discourse participants. One popular way of representing this aspect of discourse structure is through Questions Under Discussion (QUD), which correspond to the (explicit or implicit) question(s) that a given utterance is understood as addressing. As was already noted above, situation-based accounts are well-suited for incorporating this dimension, as there are concrete proposals in the literature for deriving the 'topic situation,' relative to which a given sentence is evaluated, from a QUD, e.g., by using the question extension, a set of situations, and making the topic situation the actual situation that exemplifies that set of situations; see Kratzer (2007) and Schwarz (2009) for more details. It is less clear how precisely such aspects of discourse structure could be integrated into *C*-variable approaches, as they operate on sets of individuals, and there is no obvious way to relate these to discourse structure in formal terms (which does not show that it can't be done, but I'm not aware of any existing detailed and specific proposals).

From the perspective of purely pragmatic accounts, it would seem possible to integrate a wide range of factors that could affect the reasoning processes involved in reconstructing what the speaker might have meant. However, without any concrete proposals on the table, no particular restrictive predictions can be considered. But another dimension in terms of domain restriction processing becomes relevant here, in particular the time course of resolving the domains at play. At least on the standard construal of the relevant pragmatic accounts (i.e., the 'secondary' or 'Gricean' ones in the terms of Recanati 1996), which one could label as global, the reasoning processes involved in determining what was meant by a given utterance would seem to depend on being able to assess the literally expressed content in its entirety first. The key idea is precisely that upon reconsidering the literally expressed proposition in terms of its plausibility in the utterance context, pragmatical enrichment comes to the rescue when needed. Such a view is broadly reminiscent of a 'Literal First' view on implicature processing (Bott & Noveck, 2004; Huang & Snedeker, 2009), and arriving at the pragmatically appropriate interpretation with regards to domain restriction should likely be relatively slow. While a more incremental processing implementation of such accounts may be possible, it still will be relevant what information is available at a given point in time to determine that a literal interpretation is contextually unfeasible. Again, a more detailed account is needed of how the relevant enrichment can take place step by step in incremental interpretation while building and interpreting a parse of the literal meaning. In contrast, for representational accounts, the parallel to processing of other pronouns suggests that the search for values of variable-denoting expressions in the abstract linguistic representation can take place rapidly upon encounter of the relevant structure. (The fact that these pronouns are sometimes unpronounced should not alter this, if they are routinely posited as part of noun phrase structure in parsing; and again, these considerations are entirely parallel to phonologically null pronouns in pro-drop languages.)

The experiments reported below investigate both the factors affecting choices for domain restriction as well as the time-course of these choices unfolding in online processing, as reflected in eye movement patterns in a visual world paradigm.

2 Experimenting with Domain Restriction for Definites

Two experiments using simple visual contexts, consisting of arrays of colored shapes, paired with short linguistic contexts, investigated the factors affecting the choice of domain restriction values, as well the time-course of these processes. The critical trials involve target sentences with definites that can only be interpreted if the domain is restricted to a part of the display. Reference resolution for these expressions is assessed indirectly through truth-value judgments. Participants' eye movements are tracked as the auditory stimuli unfold to assess the time course of resolving reference in light of various options for domain restriction. The basic configuration used in variations in both experiments is illustrated in Figure 1.
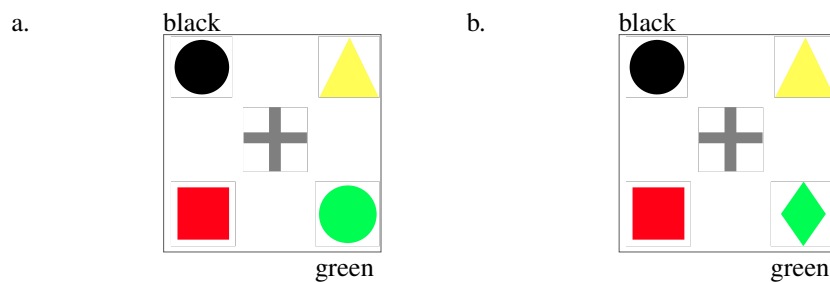

Fig. 1: Sample experimental arrays. **a** non-unique (NONU) condition with two candidate referents for *the circle*. **b** unique (U) conditions, with one candidate referent

The context and target sentences in (5) formed the center-piece of both studies below:

(5)   a. **Context:** On the top, there is a yellow triangle.   PP-FRAME
        b. **Target:** The circle is black.

Relative to the non-unique (NONU) display condition, the target sentence alone provides little help in terms of determining which circle is being referred to, apart from the fact that one of them is black. However, taking the context sentence into consideration, a possible clue enters the picture, namely the prepositional phrase (PP) *on the top*. It can be taken to suggest that the definite in the target sentence should be interpreted relative to a restricted domain that only includes the top row. On representational domain restriction accounts, this corresponds to making the predicate of being on the top the value of the C-variable or the situation consisting of the top row the value of the situation variable. Pragmatic accounts may simply posit that the top circle must be the referent intended by the speaker, in light of it being black and the top row having been discussed immediately before. The explicit task for participants was to simply indicate whether or not the description provided

by the auditory stimuli was or was not true of the presented array. The unique (U) array condition served as a control in Experiment 1.

2.1 Experiment 1

2.1.1 Design and Materials

The first experiment addresses the question of whether the role and position of the key prepositional phrase, corresponding to *on the top* in the illustration above, affects the extent to which it influences the interpretation of the definite in the target sentence. To that effect, two additional context sentences were compared to the version above, which we'll refer to as PP-FRAME, given the role of the prepositional phrase as a frame adverbial:

(6) a. On the top, there is a yellow triangle.   PP-FRAME
     b. The yellow triangle is on the top   PP-PRED
     c. The triangle on the top is yellow.   PP-NP

These context variations were designed to create minimal surface-string variations, with all the same lexical predicates in play, while varying the role and position of the prepositional phrase. In PP-PRED, it appears in final position and serves as the main predicate. In PP-NP, it is part of a nominal modifier and appears sentence-medially; note that it was prosodically deaccented in this condition, whereas the head noun (here *triangle*) did bear a major pitch accent. The initial intuition is that while in principle, the inclusion of the PP may increase the likelihood of choosing the top circle as the referent across conditions, the effect seems clearest in the PP-FRAME condition, due to the topical nature of the PP, which seems to extend over the entire discourse. The deaccented prosody of the PP in PP-NP may also indicate some form of topicality, or at least Givenness, but it's less clear to what extent this carries over to subsequent parts of the discourse. Variation due to differences in discourse structure will be of some importance in the General Discussion, as theoretical accounts differ in the options they offer for incorporating such dimensions of discourse structure.

Another important factor in assessing the overall sentence is whether or not the color adjective mentioned in the sentence matches the top circle. In line with the notion of a principle of Charity, comprehenders seem generally eager to find interpretations that hold true in the context. Therefore, Experiment 1 included an additional between-item manipulation of adjective:

(7) a. The circle is black   ADJTRUE
     b. The circle is green   ADJFALSE

In the case of ADJFALSE in the NONU condition, where the color adjective matched the other circle, the pressure of Charity, i.e., a desire to accept the sentence as true, on the one hand, and the domain restriction suggested by the PP in the

context sentence directly oppose one another. This is designed to reveal potential differences in the strength of the PP-domain effect across conditions in terms of response patterns. In the ADJFALSE-U condition, the shape replacing the other circle (e.g., the diamond in Figure 1) did have the mentioned color, but that, of course, did not affect the falsity of the statement, since it was the wrong shape.

36 items consisting of variations of the sentence-array combinations were created, each with 6 variations within the 2×3 design (Array type: U/NONU, and Context sentence: PP-FRAME/PP-PRED/PP-NP). Correspondence of the color of (one of) the circle(s) to that mentioned in the target sentence was implemented as an additional between-item manipulation: half of the sentences had target sentences in the ADJTRUE format, and the other half in the ADJFALSE format. In addition, there were 36 filler items, evenly divided into 4 types, half of which were presented with NONU displays, and the other half with U displays:

(8) NONU
  a. There's a green diamond on the bottom. On the left, there's a cross.
  b. There's a black diamond on the right. The square is on the bottom.

(9) U
  a. There's a square on the left. The circle is on the bottom.
  b. The triangle is black. The circle is green.

Within each group, two thirds of the items were false, and one third true, to roughly even out true and false responses overall given that critical items in the NONU-ADJFALSE condition, of which each participant saw 9, could easily be judged true as well.

2.1.2 Participants and Procedure

38 students participated for course credit at the University of Pennsylvania. Eye movement data was recored using an EyeLink 1000 eye tracker. Participants were randomly assigned to one of six groups, who saw a corresponding version of counterbalanced lists of a total of 72 items, with 6 critical items in each of the 6 conditions, and the fillers as described above, all in randomized order. They were instructed to simply look at the screen and press a button to indicate whether the sentences they heard were true or false in light of the display. Before each trial, participants fixated a cross in the center of the screen. Each trial began with the array of shapes appearing on the display. After 700ms, the recording of the context sentence started playing back, followed by the target sentence. Participants then pressed a button to indicate whether the description was true or false of the display. The display stayed on for another 1000ms after button press, and then the fixation cross appeared again in preparation of the next trial.

2.1.3 Results

The collected data provided three dependent variables to analyze: response patterns, response times, and eye movement patterns. We conducted mixed effect model analyses using the *lme4* package in R, with maximal random effect structures that would converge and not yield correlation parameters approaching 1. Key aspects of the outcomes for all three variables are depicted in Figures 2 and 3.
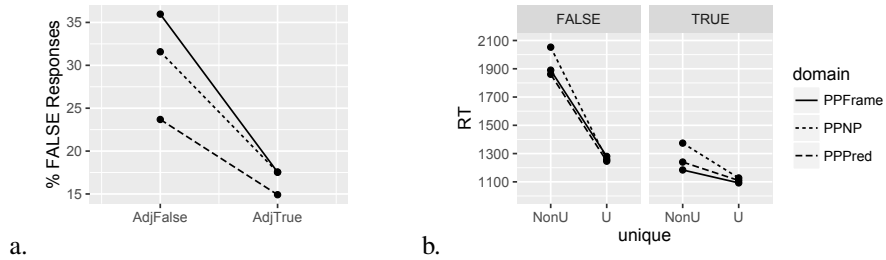

a.   b.

Fig. 2: Behavioral results from Experiment 1. **a** 'False' Responses in NONU. **b** Response Times for 'False' and 'True' Responses based on uniqueness in ADJFALSE ADJTRUE respectively
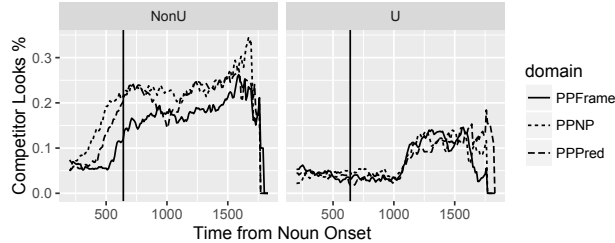

Fig. 3: Looks to competitor relative to Noun Onset time by PP-domain (vertical line indicates mean onset of adjective) for NONU and U trials

Unsurprisingly, the U conditions (results not shown in response graph) yielded floor and ceiling level 'False' responses across conditions for ADJTRUE and ADJFALSE respectively. Logistic regression analyses of the 2×3 design, with PPFRAME and ADJFALSE as baselines, therefore focused on the NONU trials of critical interest, and revealed that participants were more likely to give a 'False' judgment when the Adjective was false of the shape matching the domain introduced by the PP in the context sentence (the top circle in the illustrations above), but true of the other shape of the same type (the bottom circle); this contrast was sig-

nificant for PP-FRAME ($\beta = 1.37$, $SE = 0.40$, $z = 3.53$, $p < .001$)[5] and PP-NP ($\beta = 1.12$, $SE = 0.39$, $z = 2.84$, $p < .01$) , but only marginally significant for PP-PRED ($\beta = 0.77$, $SE = 0.41$, $z = 1.85$, $p < .1$). While the range of 'False'-response rates suggests that a Charity-based preference for 'True' responses is quite strong, this shows that the context sentences can override this preference to some extent and lead to a choice of the top circle as the referent, despite the mismatch in the color adjective. In addition, PP-FRAME yielded significantly more 'False' responses in ADJFALSE than PP-PRED ($\beta = 0.87$, $SE = 0.35$, $z = 2.50$, $p < .05$), and setting PP-NP as baseline revealed a parallel, but only marginally significant effect relative to PP-PRED ($\beta = 0.58$, $SE = 0.35$, $z = 1.67$, $p < .1$). While there were no significant interactions, this provides at least some suggestive evidence that the context sentence conditions varied in how strongly they pushed towards an interpretation where the definite referred to the shape that matched the domain indicated by the PP.

The response time analysis focused on trials with responses based on the domain suggested by the PP (i.e., ADJFALSE trials with 'False' responses and ADJTRUE trials with 'True' responses). As a 3-way (Uniqueness×Adjective×Context) interaction analysis did not indicate any significant differences across context conditions, a second analysis collapsed the context conditions and found an interaction between Uniqueness and Adjective ($\beta = 249.04$, $SE = 110.47$, $t = 2.25$), driven by the increased time taken for 'False' responses in ADJFALSE-NONU trials, which also led to significant simple effects in comparison to the ADJFALSE-U ($\beta = 491.28$, $SE = 98.18$, $t = 5.00$) and ADJTRUE-NONU ($\beta = 408.00$, $SE = 104.60$, $t = 3.90$). Separate follow up analyses for each context variation showed these effects to be present almost across the board, although the interaction did not reach significance for PP-NP. In combination with the response patterns, these results suggest that the opposing pressures from Charity and the domain suggested by the PP in the context sentence make it harder to decide on a response.[6]

Turning to the eye fixation data, we focus on the extent to which there are fixations to the competitor upon hearing the noun (e.g., looks to the bottom circle upon hearing *circle* in the above illustrations). It is apparent from the graph on the right of Figure 2 that such looks quickly emerge in the NONU condition. (The U condition basically doesn't exhibit any such looks in the first 1000ms after noun onset, with a small amount of later looks presumably due to the adjective matching the competitor in half of the trials.) But there also seems to be variation across conditions in the strength of this effect. To assess any such differences statistically, we computed empirical logits for the average proportion of looks to the competitor for the entire region, defined as beginning 200ms after the onset of the noun (*circle*) and ending 1000ms after the onset of the adjective. These Elogits then served as the dependent variable for a 2×3 interaction analysis, using the same approach as for response times above, with PP-FRAME and NONU as baselines. While there was a significant effect of the factor Unique ($\beta = -0.84$, $SE = 0.30$, $t = -2.85$)

---

[5] *p*-values reported for logistic regression are based Wald's Z tests.

[6] Note, however, that 'True' responses in ADJFALSE-NONU did not exhibit a parallel slow-down, suggesting that on such trials, only Charity may have been considered.

for PP-Frame, indicating more looks to the competitor in NONU, this effect was smaller than for the other conditions, as reflected both in significant interactions (PP-NP: $\beta = -0.76$, $SE = 0.32$, $t = -2.36$; PP-PRED: $\beta = -0.67$, $SE = 0.32$, $t = -2.07$), as well as simple effects of Context for NONU (PP-NP: $\beta = 0.65$, $SE = 0.26$, $t = -2.56$; PP-PRED: $\beta = -0.53$, $SE = 0.24$, $t = -2.25$). For the most part, these effects are already significant when just looking at the window preceding integration of the adjective, ranging from 200ms after noun onset to 200ms after adjective onset (with the exception of the PP-Pred simple effect, which approaches significance, and the PP-Pred interaction, which is not significant there), suggesting that the relevant effects of Context unfold rapidly, within a few hundred ms, after the onset of the noun.

2.1.4 Discussion

Our experimental manipulations made an impact both on online comprehension processes and response behavior. Unsurprisingly, it matters whether there are two circles in the display or just one when you try to resolve the reference for a definite such as *the circle*. In the former case, we find mixed response behavior when the color adjective does not match the circle that is in line with the domain suggested by the PP in the context sentence, with an increase in 'False' responses both relative to U-conditions, as well as relative to the NONU-condition where the adjective is true of the (equivalent of the) top circle. It is also noteworthy that when the adjective was true of the shape in the indicated domain, 'True' responses were at ceiling level across conditions. This, together with the fact that even the ADJFALSE conditions rendered a majority of 'True' judgments, suggests that there is a fairly strong pressure favoring true interpretations at play, which is presumably driven by a Charity principle. In the case where judgments were varied (NONU-ADJFALSE), we also find an increase in response times for 'False' judgments, suggesting that considering the interplay of the pressures of Charity and the domain suggested by the PP comes with additional processing efforts.

Crucially for our purposes, the Context manipulation also led to several effects, suggesting that not all ways of placing a PP in the context sentence are equivalent in terms of making a plausible domain restriction option salient. In particular, PP-FRAME exhibited the most clear effect in response patterns, with significantly more 'False' judgments than in the PP-PRED condition, while PP-NP exhibited a somewhat intermediate pattern, though not significantly different from PP-FRAME. In addition, the analysis of the eye fixation data also revealed PP-FRAME to pattern differently from the other two Context conditions. In particular, we found smaller proportions of looks to the competitor shape in the NONU condition there, and this effect at least in part already emerged while hearing the noun. This pattern is in line with the strong response pattern effect for that condition, and suggests that the relatively strong effect of sticking to the top circle as the referent due to the domain set up by the context sentence is already present right away as the definite description unfolds. Interestingly, PP-NP exhibits somewhat different behaviors on

the two measures, with a relatively large proportion of looks to the competitor early on, even though ultimately the top circle is as likely as in PP-FRAME to be the chosen referent, based on the response patterns. The special prosody in this condition may be responsible for this, at least in part, as it may have been taken to both draw attention to the top shapes but also at least temporarily lead to contrasting the top with alternative locations in the display.

2.2 Experiment 2

2.2.1 Design and Materials

Experiment 2 pursues the question about the role of the PP in the sentence and its impact on domain restriction from Experiment 1 further, but also introduces another dimension that, at least from one perspective, can be seen as relating to domain restriction as well, though via a potentially different mechanism, namely by introducing an antecedent with a noun phrase in the context sentence. This is of interest both to further differentiate how various contextual options for resolving the reference of the definite description can vary in terms of their strength with regards to online processes and response behaviors, and in light of theoretical questions about different ways in which definites can relate to their discourse context. The core PP-FRAME condition from Experiment 1 is re-used, but paired with a more minimal variant where the PP appears sentence-finally as a coda of the existential sentence (the label PP-{FRAME/CODA} is used here to make the relation between conditions across experiments transparent). In addition, there is a direct antecedent condition ANT, where the relevant shape is introduced by an indefinite noun phrase, and an indirect antecedent condition, where a plurality of shapes that includes the relevant shape is referred to in the context sentence.

(10) On the top...   -FRAME
    a. ...there's a yellow triangle...   PP-
    b. ...there's a circle and a triangle...[7]   ANT-
    c. ...there are two different color shapes...   TWO-
                                             ...on the top   -CODA

In order to provide more power in analyzing the central manipulations, all of the critical trials appeared with NONU displays and contained a color adjective that was true of the other shape of the type referred to by the description (corresponding to ADJFALSE above).

Given that at least on an interpretation drawing on the context sentence for domain restriction, all critical trials were now false, 36 fillers with comparable displays

_____

[7] The position of the relevant indefinite was counterbalanced across items.

were included that in turn were all true. The context sentences were parallel to those for critical items, with 6 per condition. The target sentences had the format in (11):[8]

(11)   On the right, there's a green circle.

2.2.2 Participants and Procedure

39 undergraduate students at the University of Pennsylvania participated in the experiment for course credit. The same procedures as for Experiment 1 were followed, using 6 counterbalanced lists of critical items such that each participant saw 6 items in the 6 different conditions, as well as 36 filler items, all presented in randomized order.

2.2.3 Results

As in Experiment 1, the dependent variables we analyzed were response rates, response times for responses in line with the PP domain, and eye fixation patterns. The overall results for these are illustrated in Figures 4 and 5.
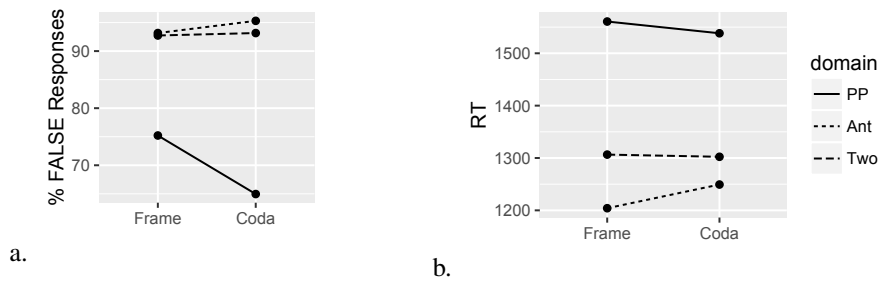

Fig. 4: Behavioral results from Experiment 2. **a** % False Responses. **b** Response Times for 'False' Responses

Starting with the response patterns it is apparent from the graph that 'False' responses were at ceiling levels for both the direct (ANT) and indirect (TWO) antecedent conditions, regardless of PP position, whereas the PP conditions exhibited lower 'False' response rates, suggesting that the effect of the former two for utilizing the material in the context sentence in resolving the reference of the definite is very strong, and less so for the PP conditions. Within the latter, the effect is

---

[8] As Chuck Clifton (p.c.) points out, the presence of the initial PP in the filler target sentences, in contrast to the critical ones, provides a superficial cue for how to respond (modulo the uncertainty of the provided domain). I'll return to this point in the discussion below.
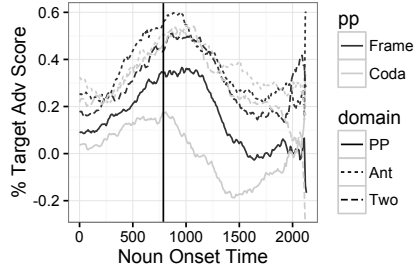
Fig. 5: Target Advantage scores relative to Noun Onset time (vertical line indicates mean onset of adjective), by Context and PP position

further modulated by PP Position, with a stronger effect for FRAME. A 2×3 logistic regression analysis, with PP and FRAME as baselines, showed that the PP 'False' rates indeed were significantly lower for both the FRAME (ANT: $\beta = -2.15$, $SE = 0.36$, $z = -5.93$, $p < .001$; TWO: $\beta = -2.06$, $SE = 0.35$, $z = -5.81$, $p < .001$) and CODA (ANT: $\beta = -3.46$, $SE = 0.42$, $z = -8.15$, $p < .001$; TWO: $\beta = -2.88$, $SE = 0.36$, $z = -7.95$, $p < .001$) conditions. Within the the PP conditions, there were significantly more 'False' responses in the FRAME condition than in the CODA condition ($\beta = 0.73$, $SE = 0.24$, $z = 2.99$, $p < .01$). Finally, there was a significant interaction between FRAME vs. ANT and PP position ($\beta = -1.31$, $SE = 0.36$, $z = -2.43$, $p < .05$), and a marginally significant one for FRAME vs. TWO ($\beta = -0.82$, $SE = 0.49$, $z = -1.68$, $p < .1$). It is worth noting that the 'False' response rates for PP-FRAME in Experiment 2 are substantially higher than in Experiment 1. This is likely due to the nature of the other stimuli within each experiment, as Experiment 2 in particular saw a high propensity to respond 'False' in NONU conditions based on the ANT and TWO conditions (also see brief discussion below).

Turning to the response time data, 'False' responses in the PP condition were slower than in the other domain conditions. This was significant in both the FRAME (ANT: $\beta = -357.49$, $SE = 82.51$, $t = -4.33$; TWO: $\beta = -262.68$, $SE = 82.74$, $t = -3.18$) and CODA (ANT: $\beta = -309.97$, $SE = 85.20$, $t = -3.64$; TWO: $\beta = -254.19$, $SE = 8285.66$, $t = -2.97$) conditions.

Finally, the eye fixation data exhibits a similar pattern. Unlike in Experiment 1, we now focus on Target Advantage scores (computed by subtracting the proportion of looks to the competitor from the proportion of looks to the target), as there were relatively few looks to the competitor overall, due to the relatively strong effect of both of the antecedent conditions.[9] As in the other two measures, two effects are apparent in in Figure 5. First, the PP-conditions seem to exhibit much lower rates of looking to the Target as compared to the competitor. Secondly, this effect

---

[9] Note that qualitatively, the overall pattern of statistically significant results for Experiment 1 is essentially the same when analyzing Target Advantage scores instead of looks to the competitor, but visual illustrations of the descriptive patterns are intuitively less accessible.

is further modulated by PP position for **PP**, but not clearly so for either antecedent condition. To assess these differences statistically, we computed empirical logits for the Target Advantage percentages, both for the noun region (up until 200ms after the onset of the adjective) and the adjective region. In both regions, mean Target Advantage scores for PP were significantly lower than for ANT (Noun: $\beta = 2.41$, $SE = 0.52, t = 4.67$; Adj: $\beta = 3.15, SE = 0.70, t = 4.53$) and TWO (Noun: $\beta = 1.35$, $SE = 0.53, t = 2.54$; Adj: $\beta = 2.74, SE = 0.63, t = 4.36$). At the same time PP-FRAME exhibited significantly higher scores than PP-CODA (Noun: $\beta = -2.06$, $SE = 0.54, t = -3.84$; Adj: $\beta = -2.41, SE = 0.60, t = -4.02$).

2.2.4 Discussion

The results from Experiment 2 yield a fairly uniform picture across the different response measures, in that the PP-conditions consistently stand out as showing a weaker impact of the PP on the domain restriction choice for the definite in the target sentence than the antecedent conditions. This effect is further modulated in that it is stronger for the FRAME condition than for the CODA condition, consistent with Experiment 1. In contrast, the domain effect was equally strong for the antecedent conditions regardless of PP position.

More specifically, we found lower rates of 'False' responses for PP, at roughly 75% and 65% in the FRAME and CODA conditions respectively. The difference between the latter two conditions further corroborates the finding from Experiment 1 that the position and role of the PP affects the strength of the impact that the availability of the corresponding domain restriction choice has. Interestingly, reference for the definite was resolved in line with the domain made available in the context sentence more commonly than in Experiment 1, where we found 'False' response rates at just under 40% for the PP-FRAME condition. There are two intuitively plausible explanations for this difference: (i) The participants for Experiment 2 may have happened to be less charitable than those in Experiment 1; (ii) the other items within the respective experiments could impact behavior in the PP-FRAME condition. In particular, the very strong domain effect found in the antecedent conditions of Experiment 2 could lead to a greater inclination to stick to the domain indicated by the PP in the PP-FRAME condition as well. Preliminary inspection of 'False'-response rates over the course of experimental sessions, by coding the trials for belonging to the first through fourth quarter of a given session, provides suggestive evidence for the latter option:[10] whereas 'False'-response rates increase across quarters in Experiment 2 and the difference between PP-FRAME and PP-CODA decreases, they fluctuate more in the ADJFALSE condition in Experiment 1 and the difference to the ADJFALSE condition increases over the course of the experiment.

Despite the much higher 'False' response rates, the response time analysis showed, again paralleling similar effects in Experiment 1, that resolving the domain, and ultimately reference, of the definite is harder for the PP conditions than

---

[10] Thanks to an anonymous reviewer both for pointing out option (i) and for suggesting a way of trying to decide between these two explanations.

for the antecedent conditions, as reflected in increased response times regardless of PP Position.

Finally, the eye fixation data provides even clearer evidence that while reference resolution of a definite like *the circle* is in general pursued rapidly upon the onset of the noun, the different ways of making the contextually salient domain restriction choice available also play an immediate role. While the antecedent conditions exhibit a strong shift towards the (equivalent of the) top circle right away, and regardless of PP position, the PP conditions already display a divergence based on whether the PP in the context sentence appeared as a frame adverbial or as the Coda of the existential sentence.

3 General Discussion

We started out with two main questions about how domain restriction choices are made in online comprehension. First, we are interested in the factors affecting these choices, and secondly, in the time course of contextual cues being integrated into the interpretation of the unfolding linguistic input. In addition to these questions arising from the processing perspective, we also want to consider how our findings relate to theoretical accounts of domain restriction. I will discuss how the main aspects of the findings above inform these questions in turn.

In terms of factors affecting domain restriction, our experiments manipulated two dimensions. First, context sentences provided a PP that could be utilized for restricting the domain to part of the display (e.g., the top row), whose position and role was varied across conditions. Secondly, we considered an additional linguistic source for resolving reference for the definite, namely an antecedent in the form of a singular indefinite or a plural that included the targeted shape. The position and role of the PP affected the interpretation of the definite, as reflected in the response patterns for the truth value judgments in both experiments. In particular, we found clear contrasts for the PP-FRAME condition, where the PP was introduced sentence initially and had the role of a frame adverbial, and variants where it either served as a predicate (PP-PRED in Experiment 1) or as a coda in an existential sentence (CODA in Experiment 2). The latter two decreased the extent to which the PP was indeed put to use in restricting the domain, as witnessed by a greater frequency of 'True' judgments based on the color of the other shape matching the nominal predicate (e.g., *circle*). In addition, the PP-NP condition introduced the PP as a nominal modifier sentence-medially, with a somewhat intermediate result in response rates, though not significantly different from PP-FRAME. Overall, the intuition for the frame adverbial cases is that they have the capacity to introduce a discourse topic that can span over the subsequent target sentence. In contrast, neither the predicative nor coda uses seem to have this effect. The PP-NP condition, where the PP was deaccented, may ultimately bring about a comparable effect, though perhaps less obviously, and less quickly so, as witnessed by the eye fixation data (see discussion below). Broadly speaking, the modulation associated with varying the role of the PP

then seems to tie in with its discourse structural properties. This is of theoretical importance, as the theoretical accounts differ in terms of the options they provide for integrating discourse structure in the way that domain restriction choices get made.

The second dimension we manipulated revealed that providing an antecedent, either directly or indirectly, had a much stronger impact on resolving reference for the definite than simply providing a PP that introduces a suitable option for domain restriction. 'False' responses in the antecedent conditions were at ceiling levels, regardless of PP position, suggesting that the impact of a preceding noun phrase referring (at least in part) to the same referent is overwhelmingly strong, leaving any further effects, including those based on a Charity principle, inoperative.

Let us now turn to the time-course of the processes involved in online comprehension for resolving domain restriction, and ultimately reference, for definite descriptions. We find that having to restrict the domain to part of the display and to decide which domain to select is associated with additional processing time, reflected in increased response times: in Experiment 1, the 'False' responses in the NonU-AdjFalse conditions were slower than in the U-AdjFalse conditions.[11] Similarly, Experiment 2 showed slower response times for 'False' responses in the PP condition, whereas the antecedent conditions didn't seem to involve any serious consideration of alternative choices, as there were no delays.

At a more fine-grained level, the eye fixation data provides evidence that choices about domain restriction are pursued rapidly as the definite noun phrase unfolds, and that the factors modulating these choices also are already at play in these early phases of interpretation. The PP-Frame conditions in both experiments exhibit relevant effects, with fewer looks to the competitor and greater target advantage scores respectively, compared to PP-Pred and Coda conditions. This effect persists throughout the adjective phase, but was already significant in the noun region as well. The PP-NP condition is interesting in that it initially patterns differently from PP-Frame in the fixation data, yielding significantly more looks to the competitor, even though final response rates are comparable. The sentence medial position of the PP may make it less prominent, and its relation to the overall discourse structure may be less transparent and more ambiguous, as nominal modifiers can also commonly give rise to contrastive interpretations. Finally, the antecedent conditions in Experiment 2 are unequivocal in their strong early preference for looking towards the target shape, regardless of PP position.

The rapid time-course of the domain restriction effects is also of interest for weighing theoretical options in this area. In particular, the fact that the process for making a domain restriction choice is already taking place as the noun unfolds is perfectly compatible with representational accounts, who would see this as parallel to pronoun resolution (I take it that it is uncontroversial that the process of determining semantic values of pronouns is initiated right upon encountering the pronoun). If *C*-variables or situation variables are routine ingredients of the representation of noun phrases, then presumably finding a value for them is part and parcel of in-

---

[11] The absence of RT increases for 'True' responses in NonU suggests that in these cases, the pressure from Charity was strongly dominant, and the PP domain option was not seriously considered.

terpreting a noun phrase as it is encountered. It is another question just how this process takes place, and what considerations it includes, of course, and I will turn to this below. But first, let us consider how purely pragmatic accounts fare with regards to the rapid interpretive effects. While there may be different options for spelling out the processing implementation of such accounts, it seems fair to say that at least the global version proposed in the theoretical literature, which requires the comprehender to first consider the overall proposition that is the literal meaning of the utterance, and then consider alternatives that would better represent what the speaker must have meant, is rather incompatible with our online results, as the noun phrase alone does not provide any clue as to what proposition will wind up being expressed by the target sentence that could help establish reference for the definite. The question is to what extent it is possible to implement an incremental version of such an account, which presumably would operate on alternative propositions corresponding to possible continuations of the sentence, but would furthermore need to provide an explicit motivation for restricting the domain when only the noun phrase is available. If Charity is the main driving factor in such accounts - as is, again, suggested by how these accounts are presented in the literature -, then the effects based on context manipulation are unexpected. In any case, considering more concrete predictions to capture the immediate contextual effects on the noun phrase would require spelling out further how the larger discourse context can guide domain restriction choices in incremental interpretation based on the information available at that time.

While this again would depend on how the pragmatic accounts are fleshed out, it is also not clear why a Charity-driven preference for true interpretations wouldn't trump all other considerations in ultimate response behavior, at least in our contexts. After all, the standard examples involving quantifiers are typically discussed in terms of the literal interpretation of the entire sentence not being a plausible candidate for being true, which leads to pragmatic reconceptualization of what true proposition might have been intended to be conveyed by the speaker. But we find both that pressures from Charity can be overriden, and that the interplay between this and other factors can vary in intricate ways. This brings us back to the role of discourse structure, reflected in our stimuli in the role of the PP, and its implications for theoretical considerations. As was already hinted at above, I would argue that representational accounts based on situation variables are particularly well-suited to deal with these effects theoretically, and barring equally compelling accounts from the other perspectives are to be preferred. Let us begin by considering what C-variable based accounts have to say about the manipulations in our stimuli. The non-linguistic context, in form of the display, does not provide any obvious predicate that could serve as a value for the C-variable. And the only part of the context sentence that can be of help is the denotation of the PP. But that is held constant across conditions, and thus does not account for the variation in the data. One might be tempted to say that the position and role of the PP correlates with how the predicate it expresses is represented cognitively, in particular with regards to its salience. But given that the PP is the only way of construing a domain (in the non-antecedent conditions) that will allow reference for the definite to be resolved, it's unclear why

this should lead to variation in the interpretation of the definite.[12] (It's also worth noting that in the PP-PRED and CODA conditions, the PP comes last and thus could be argued to be salient due to recency.) Note also that this would seem to be different from how nominal antecedents interact with entity-level pronouns, as these seem perfectly fine with either subject or predicate antecedents when there is no other antecedent around, without any sense that the link between the two is weaker in the latter.

(12)   a. A circle is on the top. It is black.

       b. The shape on the top is a circle. It is black.

Given that C-variables are just type $\langle e,t \rangle$ variants of pronouns, it is unclear why they should relate back differently to their antecedents, for that's what the PP would be, than individual pronouns, especially if no other plausible value for the pronoun is around.[13]

In contrast, situation-based accounts can be theoretically related to QUDs, and the role of the frame adverbial PP can easily be seen as indicating a QUD, such as *What kinds of shapes are on the top?* Based on that QUD, the second sentence can easily be interpreted as making a claim about the top row as its topic situation, and the situation variable in the noun phrase can be assigned that value as well. In contrast, the range of options for plausible QUDs seems broader, and more general, for the PP-PRED and CODA conditions. With the reference to the other top shape and noting its color, it seems like the entire display remains as a prominent domain of inquiry. Situation variable-based accounts thus not only offer a path for integrating effects of discourse structure on domain restriction in general, but also a fairly concrete analysis of the variation in effects in our experimental materials.

As a final note, let me briefly comment on the contrast between nominal antecedents and PP-based domain restriction in our data from a theoretical perspective. It remains an open question whether definites that seem to get their value directly through some antecedent expression do so through a special anaphoric mechanism, akin to that operative in personal pronouns, or whether it is simply yet another case of uniqueness-based reference mediated by the 'antecedent' providing the domain restriction. In Schwarz (2009), I argued that German differentiates the two cases overtly in certain cases, and it is perfectly possible that English definites underlyingly have both options available as well. In that regard, it's interesting that both antecedent conditions seem to exhibit equally strong effects, as they could be seen as differing in precisely the right way theoretically due to what I have referred to here as an 'indirect' antecedent not actually involving a noun phrase whose semantic value serves as the referent for the definite. However, part of the referent of that noun phrase serves as the antecedent, which could suffice to form a stronger link (note that

---

[12] Kratzer (2004) makes a related argument by pointing out that linguistic antecedents sometimes don't seem to be available for the interpretation of C-variables at all, e.g., in *Lisa is a phonologist. I think that most linguists$_C$ would agree with what she said.*, *most linguists* cannot be understood as 'most phonologists', despite the immediately preceding occurrence of *phonologist*.

[13] As Barbara Partee notes, however, a possible avenue to pursue is to allude to parallels with preferences certain types of pronouns display in relation to topicality.

pronouns can also work in certain such cases, e.g., *I met an interesting couple last night. He's a painter and she's a professor*). In addition, this result could in principle be due to a ceiling effect and the nature of the overall set of materials.[14] In any case, our results certainly do show that even if the two cases ultimately should make use of the same technical machinery for domain restriction, nominal antecedents clearly provide a stronger bond than other, arguably more indirect contextual indications of domains. Future work is needed to look into this variation and its relation to theoretical accounts of definites more broadly.

4 Conclusion

Domain restriction is a pervasive phenomenon that relates to central questions about interpretation in context, and the integration of various contextual dimensions in online comprehension. What do we want to know about domain restriction, as my favorite psycholinguistics teacher might have asked in a seminar? Surely a lot more than what we have been able to sketch here, but hopefully these first steps towards understanding the role of discourse structure and the time-course of its impact in online comprehension processes provide a useful starting point for more extensive models integrating insights from linguistic theory and online processing of the sort that the honoree of this volume has taught her students to appreciate.

References

Bach, K. (1994). Conversational impliciture. *Mind & Language*, *9*(2), 124–162.

Barwise, J., & Etchemendy, J. (1987). *The liar. An essay in truth and circularity*. Oxford: Oxford University Press.

Bott, L., & Noveck, I. A. (2004). Some utterances are underinformative: The onset and time course of scalar inferences. *Journal of Memory and Language*, *51*(3), 437–457. doi: 10.1016/j.jml.2004.05.006

---

[14] Another experiment in the same series, not reported here for reasons of space, provides initial suggestive evidence for differences between these two, with lower 'False' response rates for Two.

Büring, D. (2004). Crossover situations. *Natural Language Semantics*, *12*(1), 23-62.

Elbourne, P. D. (2013). *Definite descriptions*. Oxford: Oxford University Press.

Evans, W. (2005). *Small worlds of discourse and the spectrum of accommodation.* Retrieved June 3rd, 2018, from `https://semanticsarchive.net/Archive/TY5MjVkZ/Evans_Smallworlds_2005.pdf` (Honors Thesis, University of Massachusetts Amherst)

von Fintel, K. (1994). *Restrictions on quantifier domains* (PhD thesis). University of Massachusetts Amherst, Amherst, MA.

von Fintel, K., & Heim, I. (2007). *Intensional semantics.* (Unpublished lecture notes, MIT)

Huang, Y. T., & Snedeker, J. (2009). Online interpretation of scalar quantifiers: Insight into the semantics-pragmatics interface. *Cognitive Psychology*, *58*(3), 376–415. doi: 10.1016/j.cogpsych.2008.09.001

Keshet, E. (2008). Only the strong: Restricting situation variables. In T. Friedman & S. Ito (Eds.), *Proceedings of SALT 18* (p. 483-495). Ithaca, NY: Cornell University.

Keshet, E. (2010). Situation economy. *Natural Language Semantics*, *18*, 385-434.

Kratzer, A. (2004). *Covert quantifier restrictions in natural languages.* Slides for talk given at Palazzo Feltrinelli in Gargnano June 11, 2004. Retrieved 22 May 2018, from `https://semanticsarchive.net/Archive/mIzMGUyZ/Covert%20Quantifier%20Domain%20Restrictions.pdf`

Kratzer, A. (2007). Situations in natural language semantics. In E. N. Zalta (Ed.), *Stanford encyclopedia of philosophy.* Stanford: CSLI.

Martí, L. (2003). *Contextual variables* (PhD thesis). University of Connecticut, Storrs.

McCawley, J. D. (1979). On identifying the remains of deceased clauses. In J. D. McCawley (Ed.), *Adverbs, vowels, and other objects of wonder.* Chicago: University of Chicago Press.

Neale, S. (1990). *Descriptions*. Cambridge, MA: MIT Press.

Neale, S. (2004). This, that, and the other. In A. Bezuidenhout & M. Reimer (Eds.), *Descriptions and beyond* (p. 68-182). Oxford: Oxford University Press.

Recanati, F. (1996). Domains of discourse. *Linguistics and Philosophy*, *19*(5), 445–475.

Roberts, C. (1996). Information structure in discourse: Towards an integrated formal theor of pragmatics. In J. H. Yoon & A. Kathol (Eds.), *Papers in semantics* (p. 91-136). Columbus, OH: The Ohio State University.

Schwarz, F. (2009). *Two types of definites in natural language* (PhD thesis). University of Massachusetts Amherst, Amherst, MA.

Schwarz, F. (2012). Situation pronouns in determiner phrases. *Natural Language Semantics*, *20*(4), 431-475.

Stanley, J., & Szabo, Z. (2000). On quantifier domain restriction. *Mind and Language*, *15*(2), 219-261.

Westerstahl, D. (1984). Determiners and context sets. In J. van Benthem & A. ter

Meulen (Eds.), *Generalized quantifiers in natural language* (p. 45-71). Dordrecht: Foris.