

Focus improvements to weak crossover

Perna Nadathur

June 22, 2016

Contents

1	Introduction	3
1.1	Crossover phenomena	3
1.2	Weak crossover and variability	4
1.3	A processing perspective	8
1.4	Roadmap	10
2	Crossing and coreference	11
2.1	General challenges to trace theory	12
2.2	Rank, order, and direct association	14
2.2.1	Syntactic rank	14
2.2.2	Linear order	16
2.2.3	Direct association	18
3	Processing complexity and acceptability	23
3.1	Extraction and informativity	24
3.2	Coreference, alternatives, and focus	26
3.2.1	A sketch of the proposal	26
3.2.2	An overview of focus semantics	30
4	Focus improvements to weak crossover	36
4.1	A note on methodology	36
4.2	Pilot studies	37
4.2.1	Experiment I: Design	37
4.2.2	Experiment I: Predictions	38
4.2.3	Experiment I: Results and discussion	39
4.2.4	Experiment II: Design	45
4.2.5	Experiment II: Predictions	46
4.2.6	Experiment II: Results and discussion	46
4.2.7	General discussion	50
4.3	Experiment III: focus with <i>only</i>	51

4.3.1	Design	51
4.3.2	Predictions	54
4.3.3	Results	55
4.3.4	Discussion	57
4.4	Experiment IV: emphasis or intonational focus	60
4.4.1	Design	60
4.4.2	Predictions	61
4.4.3	Results	61
4.4.4	Discussion	63
5	Conclusions and questions	66

1 Introduction

1.1 Crossover phenomena

Since Postal (1971), it has been widely accepted that syntactic rules or transformations in English and other languages must be sensitive to coreference relationships between the noun phrases in the sentences to which they apply. For instance, subject-object coreference (indicated by shared subscripts in example 1) seems to block what would otherwise be an acceptable application of the *passive transformation*, shown in (2) (Chomsky 1957).

- (1) a. Charlie_i kicked himself_i.
b. *Himself_i was kicked by Charlie_i.
- (2) a. Charlie_i kicked him_j.
b. He_j was kicked by Charlie_i.

Postal introduces a wide range of data subject to these effects, much of which has given rise to extensive discussion in the literature on both transformations and anaphora. Perhaps the most influential of his examples, however, and those which have provoked by far the most debate, involve *wh*-movement:

- (3) a. Mary thinks he_i kicked himself_i.
b. *Who_i does Mary think he_i kicked?

Typically, the *wh*-operator *who* in (3b) is assumed to be base-generated in the direct object position occupied by the corresponding reflexive pronoun *himself* in (3a). This creates a puzzle: there is no immediately obvious reason that a coreferential relationship which is clearly admissible in (3a) should be blocked by the process of *wh*-fronting, but this appears to be the case. As Postal observes, the difference in acceptability seems due to the fact that the fronting operation in this case involves “crossing over” the coreferential pronoun in subject position. This generalization is supported by the fact that (4b), where the *wh*-operator is fronted from subject instead of object position, and consequently no crossing takes place, is judged to be acceptable under the indicated coreference relationship.

- (4) a. Mary thinks he_i kicked himself_i.
b. Who_i does Mary think kicked himself_i?

The critical relationship involved in *wh*-crossover, then, appears to be between the base position of the operator and that of the pronoun with which it is intended to corefer.

This characterization results in a problem for any syntactic theory which involves ordered rules and transformations. If anaphoric relationships are assigned prior to *wh*-movement, then we would expect (3b) to be grammatical just in case (3a) is. On the other hand, if anaphoric relationships are assigned after movement, then (3b) and (4b) would be expected to pattern together, since the surface-level ordering of *wh*-operator and pronoun in these two cases is much the same.

Wasow (1972) suggests that this rule-ordering paradox can be resolved by postulating the existence of an unpronounced “trace” element,¹ which is left in base position when the *wh*-operator is fronted. On this view, coreference is governed, not by the relationship between operator and pronoun, but instead by the relationship between the trace and the pronoun. Specifically, traces are only able to enter into anaphoric relationships if they do so as *antecedents* to coreferenced noun phrases: in this they behave like *referring expressions* (R-expressions, e.g. proper names). The difference between (3b) and (4b), from this perspective, is comparable to the difference between (5) and (6), where the *wh*-element has been replaced by an R-expression in base position:

- (5) *Mary thinks he_{*i*} kicked Charlie_{*i*}.
- (6) Mary thinks Charlie_{*i*} kicked himself_{*i*}.

Principle C of the standard binding theory (Chomsky 1981) blocks the anaphoric relationship in (5), but permits it in the configuration in (6).² These judgements align precisely with the judgements for coreference in (3b) and (4b). As a result, much of the transformational literature since Wasow (1972) has argued for the presence of traces (or a similar unpronounced object with the anaphoric properties of an R-expression) in any account of *wh*-movement, and crossover in particular.

1.2 Weak crossover and variability

As noted, the majority of treatments of crossover have centered around the appropriate formulation of the relevant movement and anaphora rules, taking these to be hard-coded or categorical rules in a grammar. As a consequence, the trace-based treatments have largely taken the view that crossover data is fully ungrammatical: the goal is to formulate the rules so as to permit the generation of examples like (4b) and (6), but block those in (3b), (5), and (7) (see Reinhart 1983, Koopman and Sportiche 1983, Safir 1984, Lasnik and Stowell 1991, for a few examples of this approach).

- (7) a. *Who_{*i*} did he_{*i*} greet?
- b. */?Who_{*i*} did his_{*i*} mother greet?
- c. */?Who_{*i*} did you talk about his_{*i*} sister to?

Wasow (1972), however, draws a distinction between examples of the type in (7a) and those of the type in (7b)-(7c). He argues that this correlates with a certain degree of variability in the empirical acceptability judgements rendered for the latter examples, as indicated. The distinction has to do with the relative levels of embedding of trace (or operator) and pronoun; this has since been described in terms of *c-command*.³ “Strong” crossover cases

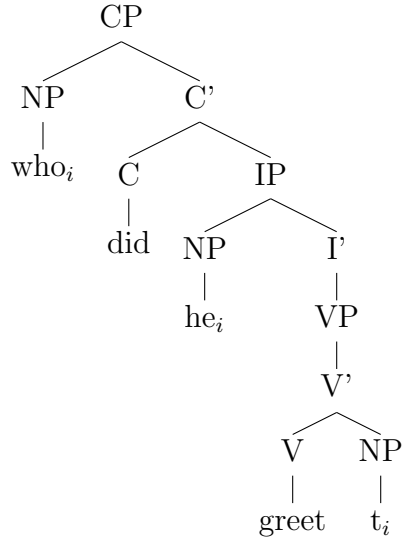
¹The original idea for the trace analysis is attributed by Wasow to P. Culicover.

²Principle C, roughly, states that an R-expression must be free (i.e. not bound to some previously-available antecedent), since they “independently refer”, or pick out entities in the world or model.

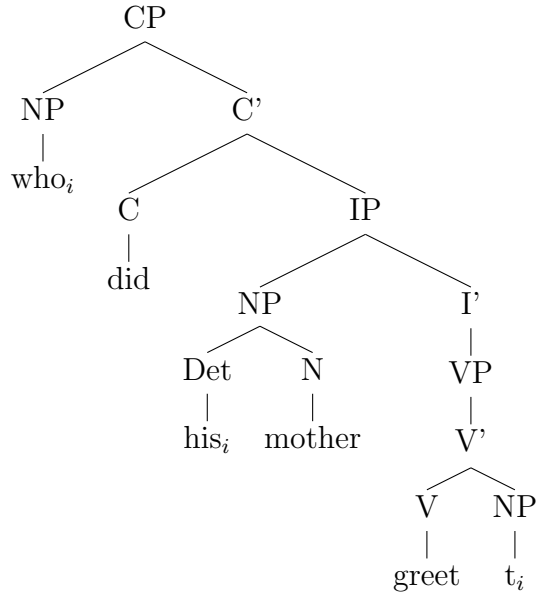
³[Adapted from Carnie (2007)]: In a syntactic tree, a node *A* **c-commands** another node *B* if neither *A* nor *B* dominate one another, and all nodes dominating *A* also dominate *B* (Reinhart 1976). Informally, a node c-commands its sisters, and the descendants of its sisters.

like (3b) and (7a), involve an asymmetric relationship of c-command between the pronoun and trace, where the pronoun c-commands the trace, but not vice versa. This is shown in (8a). In cases of “weak” crossover (WCO), on the other hand, neither trace nor pronoun c-commands the other.

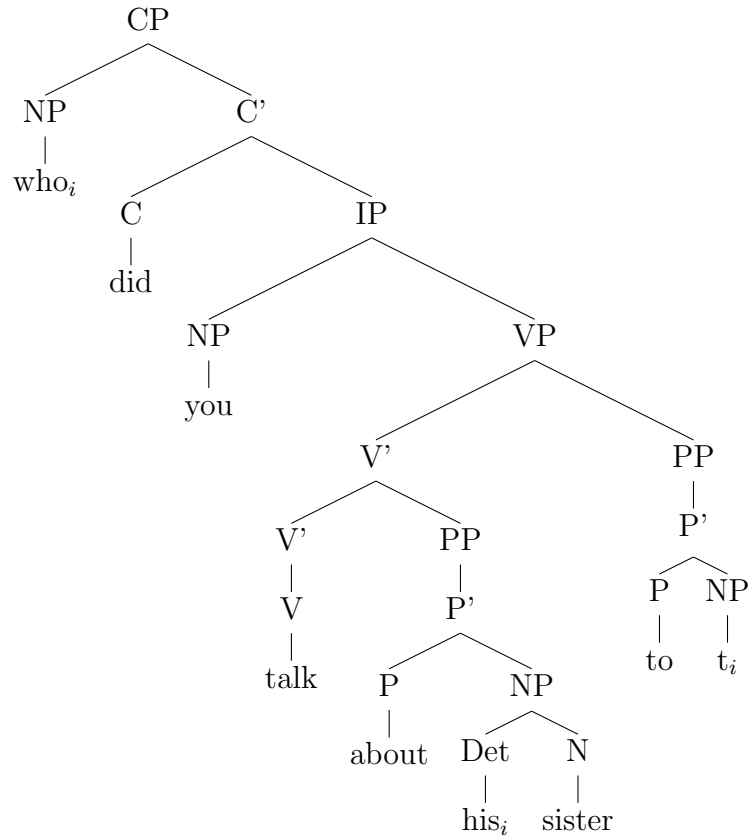
- (8) a. *Who_i did he_i greet t_i?



- b. */?Who_i did his_i mother greet t_i?



c. */?Who_i did you talk about his_i sister to t_i?



Wasow observes that while strong crossover violations do appear to be strictly ungrammatical, there is a certain degree of variability associated with judgements about WCO. On his view, this is linked to variability in judgements about the associated *cataphora* (or backwards anaphora). That is, a WCO example like (17a) is roughly as good or bad, for a given speaker, as the associated case of cataphora (17b).

- (9) a. ?Who_i did you talk about his_i sister to t_i?
 b. ?You talked about his_i sister to Charlie_i.

Wasow's proposal is that the acceptability of a given case of WCO (or associated cataphora) can be influenced, at the intra-speaker level, according to a property that he refers to as *determinateness*, but which can perhaps be thought of as specificity or semantic informativity (Hofmeister and Sag 2010, Wasow and Clausen 2011). In particular, increasing the degree of specificity or increasing semantic content associated with an extracted *wh*-element appears to improve empirical judgements about WCO.⁴

⁴This seems to be a reflex of a more general phenomenon; Karttunen (1977) observes that an extracted *which*-phrase is judged more acceptable in multiple *wh*-questions than a substituted bare *wh*-word; Maling and Zaenen (1982) observe a parallel effect for extraction from so-called *wh*-islands. See section 3.1 for further details and references.

- (10) a. */?Who_i did his_i mother love?
 b. ? Which boy_i did his_i mother love?
 c. Which blue-eyed boy_i did his_i mother love?

Something similar appears to take place with cataphora. Thus (11c) is better for many speakers than (11b), which in turn is preferred to (11a).

- (11) a. ?/* His_i mother loves someone_i.
 b. ?His_i mother loves that boy_i.
 c. His_i mother loves that blue-eyed boy_i.

This variability causes a problem for any theory of crossover data that aims to hard-wire a constraint against WCO “violations” into a the grammar of a competent English-speaker. Even granting that strong crossover is ruled out by the rules of this grammar, the fact that examples like (10c) can get high acceptability ratings shows that the WCO structure must be grammatically “legal”. If we base this admissibility on the binding and/or structural principles, we need to find a way of accounting for the reduced acceptability of the “less informative” WCO cases (e.g. 17a, 10a). Wasow’s suggestion that speakers vary individually in the degree to which “determinateness” rescues the WCO structure makes a first step towards an explanation, but does not directly provide insight as to *why* this should be the case, or how “determinateness” interacts precisely with the basis on which judgements of acceptability (e.g. in cases of extraction) are made.

In addition to the variability so far discussed, which is apparently governed by “determinateness”/specificity (or semantic informativeness), there is a second, parallel set of facts which also suggest that WCO cannot be ruled out at the grammatical level. These have to do with the observation that the inclusion of focus adverbials such as *even* or *only* seem to render WCO data unproblematic (examples from Postal 1993).

- (12) a. */?Who_i did his_i clients dislike?
 b. Who_i did even his_i clients dislike?
 c. Who_i did only his_i clients dislike?

Wasow attributes similar observations to A. Andrews:

- (13) a. ?John owns a machine_i which_i the man who designed it_i can’t understand.
 b. John owns a machine_i which_i even the man who designed it_i can’t understand.

Although (13b) differs somewhat in structure from (12b) and (12c), the crucial observation seems to be that heading the constituent containing a coreferenced pronoun with a focus adverbial eliminates or overrules whatever is potentially objectionable in WCO sentences. Since addition of *even* or *only* does not fundamentally change the syntactic structure of the WCO cases (with respect to c-command relationships, etc), it seems unlikely that the effects of these adverbials can be plausibly accounted for on any treatment of WCO which is formulated strictly in terms of hierarchical structure. It is significant that, while none of

the literature addressing WCO as a grammatical violation has challenged the idea that focus adverbs improve weakly crossed data, neither have any accounts attempted to incorporate an explanation of the phenomena.

It is also worth noting that the inclusion of focus adverbs does not appear to have a similar mitigating effect on cases of strong crossover. This preempts one particular line of explanation for the data in (12) and (13), on which focus is taken simply to “change the game” with respect to allowable coreference relationships.

- (14) a. *Who_i does Mary think he_i kicked?
b. *Who_i does Mary think even he_i kicked?
c. *Who_i does Mary think only he_i kicked?

The contrast between (14b)-(14c) and (12b)-(12c) suggests a view along the lines originally proposed by Wasow (1972): (a) strongly crossed sentences are ruled out on categorical grammatical principles, but (b) WCO cases are ruled “in” by the grammar, and rendered more or less acceptable (i.e., variable) by a second, perhaps unrelated, set of considerations.

1.3 A processing perspective

An obvious place to look for this second set of principles is in what we might think of as the “parser”. Theories of grammar are often concerned with the generation or licensing of structures and sentences, but it is of course irrelevant whether a structure is generated legally or not if a (human) parser would be unable to analyze, comprehend, and identify it as belonging to the relevant language. One line of approach to the generation vs comprehension split treats these as independent to a certain degree: the set of structures licensed by the grammar provides an upper bound on the set of comprehensible structures, but the former is not necessarily identical to the latter. More specifically, while a high degree of syntactic complexity may be permitted by the generating rules, and therefore strictly speaking “grammatical,” computational and/or processing limits on the parser might prevent such a structure from being properly analyzed or identified as acceptable.

This approach to acceptability data has been employed, for example, in explaining why certain “center embedding” structures (Miller and Chomsky 1963, Kuno 1974) seem to become less acceptable with additional levels of recursion:

- (15) a. The rat ran.
b. The rat [the cat chased] ran.
c. ?The rat [the cat [the dog bit] chased] ran.
d. *The rat [the cat [the dog [the man bought] bit] chased] ran.

Rather than incorporating a rule about the maximum number of relative clause recursions permissible (which would at least ostensibly require a generating algorithm able to keep track of the current embedding level), we can instead attribute the poor rating assigned to (15d) (and, by some speakers, 15c) to the increased computational demands of holding

the left-positioned NPs in memory during each recursion – *rat*, for instance, must be kept active in some way until the verb it matches with (*ran*) finally appears on the right edge of the structure (Dryer 1980, Gibson 1998, Karlsson 2007). Since we receive linguistic input from left to right, as it were, there is no *a priori* way for a parser to know how long the rightmost NPs will need to stay active – the simplest explanation here is that there is no finite limit imposed by the grammar, but rather a gradient limit imposed by an individual parser’s memory capacity.

The idea that processing demands can affect acceptability judgements is not unique to the phenomenon of center embeddings, although it has for the most part been explored outside of the transformational/generative framework. Kaplan’s (1974) *augmented transition network* (ATN) model of human grammar, for example, is aimed at providing a model of the “mental operations” involved in comprehension, and incorporates the idea that certain types of operation – such as relativization and extraction – may incur a higher processing cost than others, which proceed more linearly from one end of the string to the other. Highly complex structures, while perhaps permissible according to the ATN underlying sentence generation, may ultimately be designated as “unacceptable” because they overwhelm the processing or memory resources of the parser – or, more importantly, of the parser belonging to a specific individual at a specific time. Although details of the models vary, the idea that cognitive and memory resources not only vary from individual to individual, but also impose constraints on language processing which get reflected in judgement data is central to accounts of grammaticality/acceptability and competence from Deane (1991), Kluender (1992) and Just and Carpenter (1992), among others. Wanner and Maratsos (1978), in particular, show evidence of inverse correlation between the complexity of a structure involving relativization and/or extraction and the acceptability ratings assigned to it. Similarly, Gibson (1998), Hawkins (1999) and others shows a correlation between increases in dependency length and decreases in acceptability ratings. Just and Carpenter (1992), moreover, provide evidence that individuals differ in their working-memory capacity (presumably as a function of time, mood, and other non-linguistic factors), which supports the idea that some individuals are more likely to accept or reject certain complex syntactic structures than others.

Taking processing demands into account, we have the following picture. Categorical grammatical rules (for a given language) give rise to a binary judgement scale, but gradation in processing complexity (relating to e.g. online memory requirements, as with the center embeddings in example 15) generate a corresponding gradient of judgements. Strictly speaking, the categorical rules mark structures as either “grammatical” or “ungrammatical,” while processing difficulty is predicted to produce judgements along an “acceptability” continuum, but we do not necessarily expect speakers to make this distinction. In particular, we do not expect that an individual will distinguish between the unacceptability of an ungrammatical structure and that of a highly complex one; however, insofar as we expect complex but grammatical examples to be “better” in some real sense than ungrammatical ones (albeit of course “worse” than simple grammatical cases) the view from processing predicts that speakers may vary in their judgements about complex grammatical cases, but across the board will reject ungrammatical structures.

This distinction maps onto the split in judgement data between weak and strong crossover sentences. The strong examples are invariably judged to be bad, and cannot be improved either by manipulating focus content (see 14), or by the informational content of the extracted element:

- (16) a. *Who_i did Mary think he_i kicked?
 b. *Which boy_i did Mary think he_i kicked?
 c. *Which blue-eyed boy_i did Mary think he_i kicked?

On the other hand, weak crossover examples are variable to begin with (as noted by Wasow), and in addition seem susceptible to manipulations involving informativity and/or focus content. If the processing view sketched above is correct, then, it seems as if apparent WCO “violations” are the result of processing complexity, rather than ungrammaticality, while strong crossover violations actually do represent a constraint on binding/coreference relationships.

1.4 Roadmap

The puzzle surrounding crossover data, at this point, stands as follows. First, we need to find a way of articulating a grammatical constraint that will admit WCO examples but rule out strongly crossed ones. The particular way in which we formulate such a constraint, of course, depends to a certain degree on the theoretical framework in which we choose to operate. For current purposes, not much rides upon this choice; however, it is important to note that simply ruling out all cases of coreference where a purported trace fails to c-command the pronoun (as suggested by, e.g. Lasnik and Stowell 1991) will not suffice. For one, this rules out not only cases of strong crossover such as (7a), but also the WCO cases that I have argued are in fact grammatical (7b)-(7c). Moreover, it also fails to distinguish between proper WCO examples (17a) and unproblematic cases like (17b), simply because the (implicit) trace position does not c-command the relevant pronoun in either example.

- (17) a. ?Who_i did you talk about his_i sister to t_i?
 b. Who_i did you talk to t_i about his_i sister?

In this paper, I first present briefly some of the relevant crossover data and considerations, and sketch two potential ways of accounting for the strong/weak grammaticality divide that do not rely on c-command or the presence of unmarked traces, while retaining Wasow’s insight about the connection between crossover and cataphora binding.

The second area of inquiry, and the one which I am mainly concerned with here, is the nature of the complexity that gives rise to judgements of unacceptability for WCO data. We have seen that both informativity and focus manipulations seem to rescue or improve these data; any account of WCO should also, therefore, provide an explanation of the means by which these manipulations “ease” the relevant processing burden. I propose that, while WCO is ruled “in” by the grammar, it involves (at least) two relatively independent processing challenges which first of all account for the reported negative judgements and variability and

secondly interact in ways that predict improvements from the manipulations discussed here. The first challenge is one imposed by any extraction phenomenon: I provide an overview of past work which suggests that (a) long-distance filler-gap dependencies in a variety of contexts incur processing costs, and (b), that these costs can be alleviated by manipulating the “salience” (informational content, or “heaviness”) of the extracted element (Pickering and Barry 1991, Pickering 1993, Hofmeister 2007, Hofmeister and Sag 2010).

The second processing challenge involved in WCO is incurred at a more semantic level, and in particular is associated with computing the desired anaphoric relationships (this accounts for the parallel between WCO judgements and those for corresponding cataphora). Generally speaking, focus does not interact directly with anaphoric complexity, but WCO combines this with the extraction of *wh*-elements, which have been argued to invoke focus alternatives as a matter of course (Hamblin 1973, Karttunen 1977, Groenendijk and Stokhof 1984). I report on the results of an experimental study which provides the first large-scale empirical confirmation of the claim that focus particles (e.g. *only*) improve judgements of WCO; based on the results of this study, I propose that it is the combination of a binding relationship and *wh*-extraction that causes the improvement. In particular, embedding the relevant pronoun within the associate of a focus particle causes it to (pragmatically) constrain the set of alternatives that are made salient for the resolution of the *wh*-phrase. This renders the coreferenced binding relationship easier to compute, but is crucially dependent on the presence of a *wh*-element, accounting for the fact that the parallel cataphora examples do not appear to be improved by similar focus manipulations.

2 Crossing and coreference

As noted above, the majority of transformational treatments of weak crossover have relied on Wasow’s trace proposal to explain the difference between examples like (18a)-(18b) and (18c).

- (18) a. **/?Who_i did his_i mother love t_i?*
 b. **Who_i did Mary think he_i kicked t_i?*
 c. *Who_i did Mary think t_i kicked himself?*

Various characterizations of the permissible and non-permissible trace-pronoun configurations figure in accounts from Reinhart (1983), Sportiche (1985), Farmer et al. (1986), Mahajan (1990), Lasnik and Stowell (1991), Chierchia (1992) and Safir (1996), among many others. To a certain extent, this approach has been driven by the goal of accounting for weak crossover as a grammatical “violation”: note that it is at least plausible to appeal to semantic considerations (for instance, about the use of reflexive pronouns) or even argument structure considerations to simply differentiate between (18b) and (18c). The prevalence of trace-reliant explanations for WCO has led it to be taken as a central point of evidence for the existence of traces in filler-gap (or long-distance) dependencies in general.

Once we take the view that WCO is not ungrammatical, but rather at worst computationally challenging, we raise a confound for this view of extraction phenomena. In this

section, I invoke some accounts from the non-transformational and processing literature to suggest some ways of accounting for the contrast between strong (18b) and weak crossover (18a) that do not rely on the (strictly) configurational relationships entered into by an unpronounced trace. In addition to providing a more straightforward view of the strong/weak split – and, moreover, one which preserves Wasow’s insight about a parallel between cataphora and crossover – non-configurational approaches have more cross-linguistic applicability with respect to extraction, coreference, and crossing phenomena, and seem generally to be more conducive to integration with theories of the empirical computational processes that underlie the informativity and focus-based improvements to “legal” crossover data.

2.1 General challenges to trace theory

I am not in this paper especially concerned with the issue of traces in generalized syntactic representations. Insofar as WCO has in the past been presented as concrete evidence for the reality of traces in long-distance dependencies, it is worth briefly reviewing some arguments that call into question any theoretical dependence on this device. For the most part, challenges to trace theory come from outside the transformational literature; one class of arguments involves showing that syntactic phenomena that have been claimed to necessitate traces can be explained equally well in their absence, and a second involves demonstrating that postulating traces can complicate accounts of certain phenomena.

An example of the first type of challenge comes from the literature on *wanna* contraction; while (19a) permits the phonological reduction of *want to* to *wanna*, (19b) seems to be unacceptable under the same reduction (Chomsky 1976, Lightfoot 1976).

- (19) a. Who_i does Kim_j want to/wanna go to the movies with t_i?
 b. Who_i does Kim_j want to t_i/*wanna go to the movies?

This difference has frequently been cited as evidence for the presence of an unpronounced trace intervening between *want* and *to* in (19b), as shown (see e.g. Radford 1997).⁵ On this view, it is the absence of an intervening trace that permits contraction in (19a).

An immediate problem here is that the type of analysis which postulates trace nodes as being left behind by *wh*-extraction does not, *a priori*, have a means of avoiding the postulation of a gap node between *want* and *to* in the subject-control⁶ structure (19a). The evidence points to the existence of an anaphoric relationship of some sort between the subject of the matrix clause (*Kim_j*) and the (silent) subject of the subordinate clause; crucially, the subordinate subject is typically analyzed as being represented by the phonologically “null” pronoun (PRO_j), which for (19a) must be situated between the matrix verb *want* and the infinitival marker *to*. If we choose to circumvent this problem by denying the existence of a subject node in this position, it seems that much harder to make a consistent case for the existence of an empty node in extraction constructions, with which control (and raising)

⁵Similar arguments have been applied to explain contrasts in auxiliary contractions (see Bresnan 1971). I omit discussion of this argument here, but see Selkirk (1984), Sag and Fodor (1992).

⁶See Bach (1979), Culicover and Wilkins (1984), Dowty (1985), among others.

structures have something (namely, displaced elements) in common. On the other hand, if we allow an empty node in (19a) for PRO_j , it seems difficult to find a principled reason that this should not obstruct *wanna* contraction in the way that the trace in (19b) is argued to (see also Falk 2007).

Moreover, even if we attribute the distinction between (19a) and (19b) to divergent properties of trace vs. PRO empty categories, we still need to explain the apparent acceptability of contraction in examples like (20).

(20) Who_{*i*} does Kim think t_{*i*} is/think's beneath contempt?

Sag and Fodor (1992) point out that a parallel structural analysis of (19b) and (20) would postulate a trace site between *think* and *is*, as shown. They argue that data of this sort demonstrates that extraction does not involve empty categories. At the very least, however, the contrast between contraction in (19b) and (20) cannot be attributed to the intervention of a trace. If the data in both (19) and (20) are correct, then, this undermines any evidence the *wanna* contraction provides for the presence of empty categories; some other factor is needed to explain the relevant contrasts.⁷

Taking a more abstract view, a number of arguments against traces also emerge from an Occam's-Razor-type perspective. The central idea is that simpler theories are, on the whole, to be preferred – and, in particular, that the explications of certain phenomena are simplified by avoiding traces. One example of such a phenomenon involves Ross's (1967) Coordinate Structure Constraint. Sag (1998) points out that while the “element constraint” (that no element may be moved out of a conjunct) has numerous exceptions, as in (21a), the “conjunct constraint” (that no full conjunct may be extracted) is apparently exceptionless (e.g. 21b) (see also Chaves 2010).

(21) a. That's the whisky_{*i*} that I went to the store and bought t_{*i*}.
 b. *Who_{*i*} did you see John and t_{*i*}?

Unacceptability of (21b) follows immediately from a traceless theory of extraction; there is simply no node available to be conjoined with *John*. On the other hand, a trace-based theory demands a more complicated explanation of the facts: attempts to provide such an explanation require a number of additional (and perhaps somewhat *ad hoc*) assumptions either about empty categories or the operation of conjunction.

In a similar vein, Pickering and Barry (1991) argue that a significant portion of the psycholinguistic data that has been cited as evidence of the existence of traces is in fact compatible with what they call a “direct association” between an extracted element and its subcategorizer.

(22) What_{*i*} did you **give** (t_{*i*}) to Sally?

⁷Sag and Fodor (1992) argue that the fact in need of explanation is not, in fact, the absence of contraction in (19b), but rather its availability in (19a); their proposal is that *wanna-* (and *hafta-* and *gonna-*) contractions are a lexical peculiarity of a certain small class of verbs in subject-control constructions.

Studies such as Crain and Fodor (1985), Stowe (1986) and Swinney et al. (1988) show apparent activation of an extracted element at its proposed trace site. Pickering and Barry point out, however, that these studies involved examples similar to (22), in which the trace location (in parentheses) abuts on the lexical item (marked in bold in 22) which subcategorizes for the extracted element. Consequently, they suggest that the observed “activation effects” noted at the trace onset could in fact be due to a link between the filler and subcategorizer which is triggered at the offset of the subcategorizer (that is, at the point when the subcategorizer has been recognized *as* a subcategorizer).

Finally, and returning to the issue of WCO, Dalrymple et al. (2001) point out that reliance on traces introduces ambiguity about the site of extraction in certain adjunct-fronting constructions:

- (23) a. About whom_i did you talk to his_i brother?
 b. You talked to his_i brother about John_i.
 c. You talked about John_i to his_i brother.

A theory which predicts all and only “crossover” violations to be ungrammatical on the basis of the trace-pronoun configuration would predict that (23a) is sometimes ungrammatical – when it is derived by extraction from (23b) – and sometimes acceptable – when derived from (23c). This seems both *ad hoc* and inaccurate; we avoid this unhelpful ambiguity in a traceless theory.

2.2 Rank, order, and direct association

Wasow (1972) himself seems somewhat skeptical of the logic behind a trace account of crossover data. He observes that there is no evident *a priori* reason to believe that traces must class with R-expressions (as opposed to pronominals) with respect to their binding properties; that is, there is no obvious non-stipulative reason to require that traces only enter into anaphoric relationships as antecedents. On the other hand, the parallel he points out between the comparative acceptability of various WCO “violations” and the cataphoric structures he associates with them seems to capture a real effect; in setting aside the trace idea to pursue a processing account of WCO judgements, we may also wish to aim at explaining these data.

A good starting point for an alternative account of the strong/weak crossover distinction comes from outside the transformational literature. Bresnan (1995) considers WCO within the framework of *lexical-functional grammar* (LFG; Kaplan and Bresnan 1982, Bresnan et al. 2015), arguing that (cross-linguistically) *c-command* is neither necessary nor sufficient to handle the relevant data. Instead, she proposes that anaphoric relationships are broadly governed by two principles: *syntactic rank* and *linear order*.

2.2.1 Syntactic rank

The notion of syntactic rank is associated with Keenan and Comrie’s (1977) *accessibility hierarchy* (elsewhere referred to as the functional hierarchy), which is independent of any

specific theoretical approach to syntax. On this scale, subjects outrank objects (in terms of accessibility for certain syntactic operations), which in turn outrank obliques, and so on. Bresnan truncates the hierarchy to SUBJ > OBJ > OBL > COMP (from SUBJ > DOBJ > IOBJ > OBL > GEN > OCOMP; Keenan and Comrie p.66),⁸ and suggests that it figures into the grammaticality of WCO “violations” via the following *prominence* constraint:

(24) **Syntactic prominence** (adapted from Bresnan 1995)

The argument containing the pronoun may not be higher in syntactic rank (i.e. “more prominent”) than the argument containing the *wh*-operator.

This accounts immediately for the ungrammaticality of strong crossover; due to English word order constraints, the crossing configurations are precisely those which involve extracting a *wh*-operator from an argument with lower rank than the pronoun’s. Insofar as we wish to account for the parallel to cataphora, then, we might then revise (24) to the following more general principle:

(25) **Syntactic prominence, revised**

The argument containing an anaphor may not be higher in syntactic rank than the argument containing its antecedent.

(25) would, naturally, be applicable only where anaphor and antecedent occur in a single sentence.

This is not quite suited to present purposes, however. Bresnan’s account aligns with the transformational literature in a number of ways, one of which is in treating WCO (as well as strong crossover) data as ungrammatical. Observe that (26a)-(26b) are ruled out categorically by (25), as are the associated cataphora in (27a)-(27b).

- (26) a. (*)Who_i did his_i clients dislike?
 b. (*)Which lawyer_i did his_i clients dislike?
- (27) a. (*)His_i clients disliked a lawyer_i.
 b. (*)His_i clients dislike that lawyer_i.

The parenthetical judgements in (26) result from the fact that (25) considers the relative ranking of the *entire* argument structures which contain pronoun and operator, respectively. Setting aside c-command relationships, the difference between strong and weak crossover configurations can be captured by the observation that strong crossover involves an operator and a pronoun which each on their own comprise complete arguments (relative to their shared subcategorizer). Prototypical WCO cases, on the other hand, involve either an operator or a pronoun which occupies a proper subpart of the set of nodes which comprises the relevant argument. This difference can be accounted for by adjusting the syntactic prominence constraint as follows:

⁸There is debate as to the correct ranking of objects, and whether or not this is a parameter of cross-linguistic variation. In particular, whether direct objects outrank indirect objects, or if the correct distinction is between “primary” and “secondary” objects Dryer (see 1986), are both more or less open questions.

(28) **Syntactic prominence, final version**

An anaphor may not be higher in syntactic rank than its antecedent.

Indirectly, this appeals to the idea that while the canonical set of arguments/functional relations (SUBJ, DOBJ, IOBJ, etc) may have clear hierarchical positions with respect to one another (but see also Dryer 1986), ranking is “muddied” for proper subparts of these arguments. That is, while a subject (perhaps arguably) outranks a direct object, there is no straightforward ranking relationship between, e.g. a possessive specifier in the subject determiner phrase (DP), and the entire object DP (cf 26a). This muddiness allows room for potential coreference configurations involving no possible ranking violations to be preferred to those which involve uncertainty. This could plausibly account for the degree to which WCO configurations involving extraction from a lower-ranked relation over a proper substructure of a higher-ranked relation are dispreferred, despite not being *categorically* ruled out. It is worth noting that sentences using these configurations can be rephrased in a manner that satisfies the syntactic prominence constraint: compare (29a) and (29b).

- (29) a. (*)/?Who_i did his_i mother greet?
b. Whose_i mother greeted him_i?

A thorough discussion of the effect that the existence of an alternative like (29b) has on selection and interpretation of (29a) is beyond the scope of the current discussion. However, pragmatic theories of alternatives (e.g. Levinson 2000) would suggest that the existence of the structure in (29b) could (and does) affect listener preferences and thus acceptability judgements for (29a).⁹

2.2.2 Linear order

Bresnan’s treatment of WCO also appeals to a *linear prominence* constraint. This is determined by the linear order of elements in a sentence, and is formalized in Bresnan (1995) in terms of the LFG relation of *f-precedence* (p.249; see also Dalrymple and King 2013). Informally speaking, the linear prominence constraint requires that the coreferenced pronoun not occur to prior to any part of the structure associated with the operator – including, crucially, its base position. On Bresnan’s account, this position is occupied by a trace or empty category, which is linked (at the functional level of LFG) to the “displaced” operator (see Kaplan and Bresnan 1982, for an adaptation of trace theory to the LFG framework).

Once we eliminate traces, however, it is not immediately obvious that the linear prominence constraint does any real work in governing weak crossover or coreference in general (insofar as the theories currently under discussion aim at a grammatical characterization of WCO “violations”). In an example like (10a), repeated below, absence of a trace means that the operator appears fully to the left of the pronoun coreferenced with it; any instability in acceptability, then, cannot be attributed to a linear ordering violation.

⁹The reasoning involved would presumably be some form of the following: if a speaker intended a coreferenced interpretation, they could have chosen the less complex structure in which to convey this, and failure to do so therefore suggests (or implicates) the deliberate *lack* of intention to communicate coreference.

(10a) Who_i did his_i mother love?

English word order constraints typically mandate that elements with higher syntactic rank precede those with lower; thus, in general, configurations in which Bresnan’s linear prominence constraint is violated are also in violation of the syntactic prominence constraint. There are, however, a limited number of situations in which this generalization does not hold, and it is worth considering here whether or not these provide any motivation for a linear order restriction/effect on the acceptability of coreference.

One place where Bresnan argues for the relevance of linear prominence is in examples involving extraction from one of two oblique arguments. She reports the following judgements for (30a)-(30b).

- (30) a. *Who_i did you talk to her_i mother about (t_i)?
b. Who_i did you talk about (t_i) to her_i mother?

Since both operator and pronoun are contained in oblique arguments of *talk*, they have equivalent syntactic rank for Bresnan (cf 24), and thus her syntactic prominence constraint is unable to account for any difference in acceptability between the examples in (30). On the other hand, the proposed trace (marked) in (30) occurs to the right of the coreferenced pronoun, meaning that the pronoun *precedes* the operator (with respect to f-precedence and the linear prominence constraint). This contrasts with (30b), where “crossing” of the operator and pronoun is avoided. For Bresnan, then, it is linear prominence alone that predicts the diverging judgements reported in (30).

I do not believe that the judgements in this case are straightforwardly reflective of a grammaticality difference between (30a) and (30b); rather, I would like to assimilate the judgement for (30a) to the general theory of WCO “violations” being explored in this paper. In particular, the empirical contrast – that (30a) is rejected at a non-unanimous but consistent rate, while (30b) is rarely rejected, if ever – should be reflective of a contrast in processing complexity between the two examples. As in Bresnan’s account, it will not be possible to rely on syntactic prominence (28) to predict this: both examples involve extraction of an oblique argument over an (unranked) argument-contained possessive anaphor, and are identical at this level of abstraction. The only observable source of difference between (30a) and (30b) is the order in which the two post-verbal arguments appear; this suggests that some principle of linear order does come into play in determining the processing complexity of sentences involving the combination of coreference and extraction that we are interested in with respect to WCO.

Of course, it might be the case that this principle is only relevant in cases like (30a) and (30b), where English word order constraints allow some flexibility. I do not propose to take a stance one way or another on this point, but it is worth observing that the adjustments that improve judgements on examples like (29a) seem to have the same effect on (30a).

- (31) a. Which student_i did you talk to her_i mother about?
b. Who_i did you talk to only her_i mother about?

Since both increasing the informativity of the extracted element and manipulating the focus structure can apparently improve (30a), it seems reasonable to conjecture (at least for the time being) that the same considerations involved in the processing complexity of this example are also at work in WCO in general. In particular, we may as well take it that some consideration of linear order comes into play in computing the extraction and binding relationships of “weakly crossed” sentence, alongside the principle of syntactic rank as previously discussed (or something doing similar work).

In addition, Bresnan’s linear prominence constraint is motivated in large part by reference to languages whose word order is either reversed from that of English, or more free overall. According to data originally reported in Georgopoulos (1991a,b), the Western Austronesian language Palauan, which exhibits VOS order, shows “the mirror image of what is predicted” for English WCO constructions (p.210-11); in cases where syntactic rank cannot predict a problem, Bresnan points to linear order as the determining factor. Moreover, she suggests that languages may vary as to whether they require one or both prominence constraints to be met; data from Mohanan (1983) suggests that the Dravidian language Malayalam is *only* sensitive to linear order in computing coreference relationships in crossover-type situations. A similar account is given for Hindi/Urdu, on the basis of data and reported judgements in Mahajan (1990), Mohanan (1990) and Butt (1993). Elsewhere, Berman (2000), Bresnan (1994), and Dalrymple et al. (2001) argue that German (among other languages) simply requires *one* of the two prominence constraints to be met: examples satisfying syntactic prominence rules may still “violate” the linear order constraint without being judged unacceptable (at a statistically significant rate).¹⁰ See Fanselow et al. (2005) for experimental data on WCO in German (and an alternative account of the constraints involved).

To my knowledge, data on the potential variability of the crosslinguistic judgements involved is not readily available in the literature. However, assuming that the observations are largely accurate, the account being developed here would necessarily predict that an instability in the judgements which parallels that observed by Wasow and others for English WCO data. On the added assumption that this instability would similarly be positively affected by informativity and focus manipulations, the apparent relevance of linear order to Palauan, Malayalam, Hindi/Urdu, and German (at least), as well as to English (above) offers a strong motivation for considering how to integrate a “linear prominence” effect on processing into a traceless treatment of crossover data. In the following section, I sketch one possible approach to linear order considerations.

2.2.3 Direct association

Bresnan’s linear order constraint is predicated on the inclusion of traces in the tree structures associated with sentences involving *wh*-extraction (cf. Kaplan and Bresnan’s 1982 treatment of long-distance dependencies). This approach will not work here. In a traceless theory, the variants (30a) and (30b), repeated below with traces omitted, are not (at least in any obvious way) distinguished by the precedence relationship between the operator (structure) and the

¹⁰Presumably, the reverse situation is also in evidence.

coreferenced pronoun. In particular, since the operator’s surface position is to the left of the pronoun, Bresnan’s definition of f-precedence (*sans* trace) would treat the operator as preceding the pronoun, satisfying her linear prominence constraint in both cases.

- (32) a. (*)/?Who_i did you talk to her_i mother about?
 b. Who_i did you talk about to her_i mother?

Intuitively, however, any empirical difference between these two examples that is to be associated with linear order must capitalize on the fact that the order of the oblique arguments (or, more specifically, of *to her_i mother* and *about*) is reversed moving from one to the other. The question, then, is how to relate the operator’s position to this difference.

Building on Kaplan and Zaenen’s (1989) traceless treatment¹¹ of long-distance dependencies in LFG, Dalrymple et al. (2001) suggest that the relevant difference can be captured by observing that “linear prominence requirements between an operator and a pronoun are determined by *overt* material which indicates the syntactic role of the displaced material” (p.71; emphasis mine). In other words, what matters for (32a)-(32b) is not the ordering of operator *who* and pronoun *per se*, but rather the order in which *her* and *to*, as the preposition that selects for *who*, occur. From inspection of the single data point (32), we can conjecture that a well-formed string in which the operator’s subcategorizer (selecting element) precedes the coreferenced pronoun seems “better” than one in which the subcategorizer follows the pronoun.

To make sense of this observation, I return to the discussion of memory load and processing cost from the introduction. As observed, sentences like (32a) and (32b) seem to involve two processing challenges: a long-distance dependency and the coreference relationship between pronoun and *wh*-operator. Assuming that a fronted (displaced) element needs to be held in some way “active” in memory until – and only until – its subcategorizer is encountered, the “bad” variant (32a) requires more resources than the “good” one (32b), due to the later arrival of the subcategorizer *to* in relation to the position of the extracted operator. Moreover, this assumption means that (32b) allows the dependency relation to be parsed and discharged before the coreference relationship needs to be established; on the other hand, the two computations are interleaved in (32a), meaning that the coreference relationship must be established while the dependency has yet to be resolved. Of course, with respect to the examples in (32), this interleaving (as well as the length of the dependency) does not distinguish the Dalrymple et al. (2001) proposal from Bresnan’s trace-dependent account – this is because, as shown in (30), the proposed trace in both cases is immediately adjacent to the subcategorizer. Thus, any measure of processing complexity concerned with (a) the distance between filler and trace and (b) the order of pronoun and trace, on the one hand, will make the same predictions (at least on the surface) as one concerned with (a) the distance between “filler” and subcategorizer and (b) the order of pronoun and subcategorizer.

Adjacency between a filler’s proposed trace and its subcategorizer occurs often in long-distance dependencies (although it is not universal). As noted in section 2.1, this is a central

¹¹Kaplan and Zaenen (1989) rely on *functional uncertainty* to encode unbounded dependencies, which (generally speaking) allows a particular element to be associated with more than one syntactic relation/function at functional structure: e.g., *who* is associated both with the OBL and with the FOCUS roles in (32).

point in Pickering and Barry’s (1991) argument for the “direct association hypothesis,” which postulates a direct link between a “displaced” element and its subcategorizing predicate or preposition. They point out that a large quantity of the apparent psycholinguistic evidence for the existence of traces, which shows “reactivation” for an extracted element at the location of its proposed trace, could equally well be explained on direct association. Swinney et al. (1988) found associative priming effects at the onset of the trace site (marked) for the extracted element in sentences like (33) which were crucially absent *prior* to the preceding word; however, this is consistent with a theory on which the filler’s properties are reactivated at the *offset* of the subcategorizer, but not before. In (33) the trace-extracted element relationship is annotated as usual, and the “direct association” is indicated by marking both filler and subcategorizer with boldface.

(33) The policeman saw the boy **that**_{*i*} the crowd **accused** *t*_{*i*} of the crime.

Moreover, motivated by syntactic theories such as Kaplan and Zaenen’s version of the LFG architecture, as well as Ades and Steedman’s (1982) flexible categorial grammar (in which the proposal is formalized), Pickering and Barry argue that direct association is more parsimonious for examples like (33) than a trace theory of extraction. This is because, as they point out, direct association postulates only *one* (potentially unbounded) dependency relationship – between the “filler” and subcategorizer” – rather than the two required by a trace theory – the co-indexed filler-trace relationship in (33), and a second dependency between the subcategorizer and the trace, through which syntactic roles/functions must be established. In the latter case, both of these relationships are associated with recognizing the structural location of a “phonologically unrealized intermediary” (p.231). The second (subcategorizer-trace) relationship might not add significantly more processing complexity in cases of trace-subcategorizer adjacency such as (30) and (33), but the difference between a trace theory and the direct association hypothesis becomes more pronounced for examples like (34). Here, the trace-subcategorizer relationship is annotated with superscripts.

(34) John found the saucer [**on which**]_{*i*} Mary **put** ^{α} the cup *t*_{*i*} ^{α} .

The predicted system of nested (and in some crosslinguistic cases, crossing) dependencies becomes even more complex with multiple extractions:

(35) John found the saucer [**on which**]_{*i*} Mary **put** ^{α} the cup [**into which**]_{*j*} I **poured** ^{β} the tea *t*_{*j*} ^{β} *t*_{*i*} ^{α} .

In addition to these observations, Pickering and Barry draw support for direct association from cases where extraction around (or of) a “heavy” NP seems to improve interpretability. They point out that if dependencies must be resolved by reference to a trace in the filler’s base position, then clefted structures like (36a) should be at least as difficult to parse as their “canonical” counterparts (36b).

- (36) a. That’s the prize_{*i*} which we gave [every student capable of answering every single tricky question on the details of the new and extremely complicated theory about the causes of political instability in small nations with a history of military rulers] (*t_i*).
- b. We gave [every student capable of answering every single tricky question on the details of the new and extremely complicated theory about the causes of political instability in small nations with a history of military rulers] a prize.

However, the heaviness of the indirect object NP makes (36a) by far the easier of the two variants to comprehend. This is unremarkable on a direct association theory, since the extracted direct object can be “discharged” prior to the heavy NP (in particular, at the offset of *gave*), but requires explication if the dependency must remain active/unresolved until the arrival of the trace (at the end of the sentence in (36a)).¹²

Adopting a direct association view of extraction allows us to “update” Bresnan’s linear prominence constraint to predict acceptability differences between sentence pairs like (32), without ruling out the “bad” variants as fully ungrammatical. The discussion of (32) shows us how this might proceed; in particular, if the dependency is still unresolved when the coreference relationship needs to be established, direct association predicts that the sentence will be harder to process, and thus likely to be rated less acceptable, simply because greater memory resources are required for correct parsing. This is the crucial difference for examples like (32), where the “good” version has the filler’s subcategorizer preceding the coreferent pronoun (and the “bad” version does not). Let us consider what it predicts for cases where the relevant subcategorizer is the verbal predicate itself, rather than a preposition.

- (37) a. [Who_{*i*}]_{FILL} did [his_{*i*}]_{PRO} mother [love]_{SUBC}?
- b. [Whose_{*i*} mother]_{FILL} [loved]_{SUBC} [him_{*i*}]_{PRO}?
- c. [Who_{*i*}]_{FILL} [loved]_{SUBC} [his_{*i*}]_{PRO} mother?

Syntactic prominence does not establish a ranking between the extracted *who* and a possessive pronoun in the subject argument. On the story being sketched here, this means that syntactic prominence leaves (37a) in a sense susceptible to other processing factors; we find, in fact, that the subcategorizer for the *wh*-operator follows the pronoun in this example. In other words, the long-distance dependency and the coreference relationship are “interleaved” in this example, as in (32a). On the other hand, if we examine the unproblematic variant (37b), we see that the entire subject has been extracted “over” the object, in addition to which the long-distance dependency is closed at the offset of *loved*, prior to the coreferenced

¹²Pickering and Barry do not mention it, but it seems to me that a similar argument could be made for the variant of (36b) in which the heavy NP is fronted:

- (i) [To every student capable of answering every single tricky question on the details of the new and extremely complicated theory about the causes of political instability in small nations with a history of military rulers]_{*i*} we gave a prize (*t_i*).

pronoun. (37c) (although semantically different) may present a similarly interesting comparison: even if syntactic prominence does not rank subjects higher than an object-contained possessive pronoun, we find that the dependency is again completed prior to the establishment of coreference, predicting that, as observed, (37c) will be an unproblematic sentence under the indicated interpretation.

The purpose of this discussion – and that of the preceding subsections – is not, of course, to provide a fully elaborated processing theory of WCO that can immediately replace the existing grammatical ones. Instead, I aim to establish the workability of such an account, with reference to the specific considerations and data contrasts that have motivated previous accounts – in particular, to establish the workability of an account that “leaves room” for the observable improvements to WCO effected by informativity and focus manipulations. The following discussion of these improvements will engage with the role played by a “processing” version of the prominence constraints; establishing a more formal version of the proposal sketched here would necessitate additional data, including crucially data from controlled experiments, but that is beyond the scope of present aims.

It will be noted that while a grammatical account does not seem to leave room for the observable improvements to WCO sentences, I have not made a WCO-specific case that direct association is preferable to a trace-based account. In the WCO-specific examples considered in (32) and (37), a processing view which takes into consideration whether or not the dependency between a filler and its trace is interleaved with the coreference relationship will make the same predictions as one which is concerned with the interleaving of the filler-subcategorizer dependence and the coreference relationship. This is of course because these examples represent cases where the proposed trace site abuts on the location of the subcategorizer.

Before moving on to an examination of the informativity and focus improvements, therefore, I include briefly some (informal) data which suggests that a syntactic prominence/direct association account of WCO may fare better with respect to predicting acceptability judgments than one which favours trace-based dependencies (see Nadathur 2013). The crucial cases for comparison are ones which separate the filler’s subcategorizer and the location of the trace site – in particular, cases where the subcategorizer and trace appear on either side of the coreferenced pronoun. Restricting ourselves to English, “pied-piped” constructions (Ross 1967) provide a relatively reliable way of doing this. In the following examples, the proposed trace is marked parenthetically.

(38) [To whom_i]_{FLL} did you [give]_{SBC} [her_i]_{PRO} book (t_i)?

The subcategorizer in (38) precedes the pronoun, while the trace would be assumed to follow it. Direct association would therefore predict that this example is relatively unproblematic, while a trace account would predict a similar rejection rate for (38) as for (32a). As reported in Nadathur (2013), an informal survey found both this and structurally identical examples (i.e. using *give*-type verbs) to be acceptable in all cases. Although the status of an oblique indirect argument relative to a direct object in double-object constructions is not fully understood, object-object variants like (39) were also found acceptable by all

informants. Similarly, (40), the pied-piped version of (32), was found acceptable in all cases (by contrast to example 32a).

(39) [Whose_i book]_{FLL} did you [give]_{SBC} [her_i]_{PRO} friend (t_i)?

(40) [To whom_i]_{FILL} did you [talk]_{SUBC} (t_i) about [her_i]_{PRO} mother (t_i)?¹³

Further discussion, including of data where both operator and pronoun belong in adjuncts, and of multiple and parasitic gap constructions, can be found in Nadathur (2013). A more complete comparison of direct association and trace-dependent processing accounts must await further data, both within English and crucially from other languages which exhibit WCO effects. For current purposes, I take it that this discussion has demonstrated that an account based on syntactic prominence and direct-association is at least as viable as one predicated on the existence of empty categories.

3 Processing complexity and acceptability

As discussed in sections 1.2-1.3, a processing account of WCO is motivated by empirical evidence that judgements of the relevant sentences can be improved by informativity and focus manipulations. In particular, I suggested that these adjustments improve judgements by easing the processing costs associated with WCO data, thereby rendering them easier to parse and/or interpret in the intended fashion. The crucial question, of course, is how these particular manipulations interact with the specific challenges posed by WCO.

The proposal being put forward here is that processing WCO sentences involves two high-cost procedures: resolving the *wh*-extraction, and correctly co-identifying the pronoun with the *wh*-operator. In particular, I suggest that the coreferential *wh*-questions that are typically treated as WCO “violations” (i.e. those which are frequently judged to be unacceptable) are precisely those cases where the dependency and coreference relationships supervene on one another. This aligns with the predictions of a variety of aforementioned processing models, including Gibson (1998), Just and Carpenter (1992), and Warren and Gibson (2002): in particular, performance on certain computations is predicted to be disrupted (in some way) by intervening demands on the processor, whether linguistic or otherwise. From this perspective, the processing demands of establishing the coreference relationship in WCO interfere and affect performance on the *wh*-extraction, and vice versa. Separating the two processes would therefore naturally be predicted to improve the acceptability of *wh*-questions involving coreference, thus accounting for the difference between (32a) and (32b), repeated below from the preceding discussion.

(32) a. (*)/?Who_i did you talk to her_i mother about?

b. Who_i did you talk about to her_i mother?

¹³The trace is marked in two places in this example since the objects are freely ordered; while the first possible location for the trace would make the same prediction – more or less – as direct association, it seems to me that the mere fact of base-position ambiguity with examples of this sort should already provide a reason to disprefer the trace account.

In addition to this, however, the processing account predicts that any means of alleviating the processing load associated with *either* the extraction or the coreference relationship will in turn boost performance on any other tasks imposed by a WCO sentence. As a result, the acceptability of the sentence will improve overall (although perhaps by not as much as if the two high-cost computations were simply disentangled). I propose that informativity and focus manipulations improve WCO data by doing precisely this. In particular, increasing the informativity of an extracted element lowers the processing cost of the dependency; at the same time (but somewhat orthogonally), modification of the pronoun-containing constituent with a focus adverbial increases the “salience” of binding between operator and pronoun, which alleviates the cost of this computation. The two manipulations therefore operate independently of one another, but since they intersect in WCO data, improving one challenge in a sense frees up resources for processing the other, and allows the improvement to project to the sentence overall. In this section, I set out the proposed effects of each of these manipulations in further detail.

3.1 Extraction and informativity

The idea that informativity (or what Wasow refers to as “determinateness”) can aid in the resolution of *wh*-dependencies is neither new nor novel to the current investigation, as noted previously. Independent of data from WCO, a tendency for “more specific” *wh*-phrases to improve (questionable) extractions has been observed by Karttunen (1977), Maling and Zanen (1982), Pesetsky (1987), and Kroch (1998), among others. In particular, there is a nontrivial body of evidence that certain dependencies usually thought of as ungrammatical extractions from “island” configurations (Ross 1967) can be improved by content and information adjustments that do not alter syntactic considerations (e.g. *c*-command relationships, constituency, etc). For instance, the “superiority” violation in (41a), where a bare *wh*-object is fronted over a (higher-ranked) bare *wh*-subject, is evidently improved by replacing the *wh*-phrases with *which*-NP constructions. Karttunen (1977) notes only the contrast between (41a) and (41b), but it is relevant that the critical replacement seems to be of the extracted element. By contrast, (41c), in which only the object is substituted, is still an improvement over (41a), but (41d), where we substitute only the subject, is the same or perhaps slightly worse than the original data point.

- (41) a. (*)/?What did who get?
 b. Which medication did which patient get?
 c. Which medication did who get?
 d. (*)/?What did which patient get?

These data support Deane’s (1991) proposal that the ability of an interpreter to compute a long-distance dependency is in some sense a function of their ability to (a) attend to the displaced element and (b) attend to the retrieval site (or location thereof). Specifically, if we take it that more involved/longer *wh*-phrases are more complex to parse, and, as a result, remain more “active,” (cf. Vasishth and Lewis 2006), we predict first of all that a

long-distance dependency involving a *which*-NP will be interpreted more easily than the same dependency with only a bare *wh*-operator, and, secondly, that replacing a less complex intervening bare *wh*-phrase with a more complex *which*-NP (as in 41d) will have the reverse effect.

Building on arguments from Kluender (1992, 1998, 2005), Hofmeister and Sag (2010) argue that judgements of unacceptability for island violations like (41) result from an “accumulation of performance-related difficulties,” which can be manipulated with the presence or absence of relevant cost-incurring features of a given construction (p.367). One of these is the complexity of the extracted element: Hofmeister (2007) shows that increasing syntactic and semantic complexity of a filler improves retrieval at later points. This effect is proposed to result from the increased effort of processing complex fillers, which as a result are more strongly activated in memory, and thus more easily retrieved at relevant points later in the sentence.¹⁴ Intuitively for *wh*-phrases, once a complex filler has been parsed or interpreted, richer semantic content or informativity is also likely to reduce the number of discourse-relevant alternatives that are available as resolutions for the pronoun (see also Pesetsky 1987, on D(iscourse)-linking).

While Hofmeister (2007) examines this idea for extractions in general, Hofmeister and Sag (2010) investigate the effect of filler complexity (among other factors) on *wh*-extractions in particular. Using self-paced reading tasks (Just et al. 1982), they examined the effect of replacing a bare *wh*-phrase with a *which*-NP in various island configurations: in particular, for violations of the “Complex NP constraint” (42) and for violations of *wh*-islands (43) (Ross 1967).

- (42) I saw *who*/⟨*which convict*⟩ Emma doubted the report that we had captured in the nationwide FBI manhunt.
- (43) a. **Context:** Albert learned that the managers dismissed the employee with poor sales after the annual performance review.
b. *Who*/⟨*Which employee*⟩ did Albert learn whether they had dismissed after the annual performance review?

In both cases, Hofmeister and Sag found that, after an initial slowdown attributable to processing a more complex *wh*-phrase, *which*-NPs resulted in significantly faster reading times (over the dependency) than bare *wh*-phrases in all conditions. Importantly, in follow-up studies involving acceptability judgements on the same materials, they found that the stimuli which were processed more easily were also rated higher than their bare *wh*-counterparts.

These results support the overall hypothesis presented here in a few ways. First, the correlation found between processing and acceptability ratings corroborates the central hypothesis that increased processing complexity decreases acceptability (above a certain baseline). Moreover, Hofmeister and Sag’s results from *wh*-extractions in island configurations show that increasing the informativity (or specificity, or “determinateness”) of the displaced

¹⁴In addition to the arguments from Vasishth and Lewis (2006), this view is further supported by evidence that retrieval of elements in recall tasks is facilitated by increasing the intensity of semantic processing demands: see Anderson and Reder (1979), Bradshaw and Anderson (1982), McDaniel et al. (1989).

element facilitates the resolution of long-distance dependencies involving *wh*-operators. Consequently, similar modifications to WCO sentences should, in a sense, be expected to “free up” memory resources for performing any other necessary computations; we expect informativity to improve WCO overall.

Recently, Wasow and Clausen (2011) have investigated the effect of informativity manipulations on WCO. Although results from their study are preliminary (and in some cases inconclusive), they seem to support a role for increased *wh*-specificity in raising acceptance rates. Interestingly, however, Wasow and Clausen found that the informativity effect in WCO was weaker than that found by Hofmeister and Sag in island extractions, in addition to which, more “informative” WCO data continued to receive low acceptability ratings compared to configurations not typically regarded as involving crossover (although they were rated higher than ungrammatical controls). This result is (so far) unexplained on Wasow and Clausen’s original hypothesis, which was that pronoun-antecedent resolution would be facilitated by informativity manipulations. Crucially, this hypothesis differs slightly from the present proposal: on the current hypothesis, Wasow and Clausen’s preliminary results are more to be expected. If informativity improves the extraction challenge, but does not directly interact with the overlapping task of establishing a non-canonical (or cataphoric) reference relationship, we expect that it should improve the overall acceptability level of a WCO sentence, but not that it should altogether eliminate the acceptability-lowering difficulties that interpreters face.

In addition to observational data from various proponents of processing accounts of island and extraction phenomena, studies like Hofmeister and Sag (2010) and Wasow and Clausen (2011) demonstrate rather convincingly that acceptability judgements are at least sometimes a reflection of processing difficulties, rather than strictly of grammaticality considerations. In particular, since informativity manipulations can be shown to improve the relevant data, it seems clear that these manipulations ease the processing cost associated with *wh*-extractions, and the activation hypothesis put forward by Vasishth and Lewis (2006) and furthered by Hofmeister (2007) seems as good as any for the time being. It is reasonable, therefore, to conclude that informativity produces a similar facilitation result in extractions in WCO sentences; the fact that these data remain “worse” than their uncrossed counterparts is therefore plausibly a reflection of an intersecting or superimposed processing demand. I claim that this challenge is binding, as discussed in the next section.

3.2 Coreference, alternatives, and focus

3.2.1 A sketch of the proposal

I take it to be an uncontroversial assumption that any sentence or phrase containing a third-person pronominal element requires a certain baseline level of cognitive effort to fully interpret. Generally speaking, we can associate this effort with the selection of the most likely (relevant, etc) referent for the pronoun in question from the contextually-restricted universe of discourse. Certain grammatical features (e.g. gender and number) can assist in this task, but I will abstract away from this here.

The first question to be asked, then, in attempting to understand the role that coreference plays in the processing of WCO sentences, is whether the challenge involved in resolving the reference of the coreferent pronoun is the same or substantively different from that posed by resolving the reference of a pronoun in the general case. Since I have characterized the problem of WCO as due to the interleaving of an extraction relationship with the coreference relationship, and, moreover, since the preceding section established that extraction involves a specific computational challenge, and we have now additionally assumed that reference does as well, there is no *a priori* reason to assume that there is something special about the coreference involved in WCO. Indeed, it may be that nothing particular in the hypothesis I am laying out will hang on this question; nevertheless, I propose that there is something specific about WCO coreference which increases the demands of resolving the pronoun's referent over that of resolving coreference in a non-WCO configuration.

To understand why this might be the case, I return to Wasow's (1972) observation that WCO data seem to parallel cataphora. His original suggestion was that an instance of WCO is comparable (in acceptability) to the case of cataphora that it would (in some sense) be "derived" from on a transformational analysis.

- (44) a. (*)/?Who_i did his_i mother greet?
 b. (*)/?His_i mother greeted someone_i.¹⁵

This parallel was based on a theory of *wh* movement, in which the trace of the *wh*-operator entered as an antecedent into a relationship with the coreferential pronoun. In the absence of a trace, however, the only anaphoric relationship to be established in a sentence like (44a) is directly between the *wh*-operator as the antecedent and the pronoun *his*. Although it is certainly plausible that we could find a structural characterization that would render (44a) cataphoric in the canonical sense, this particular antecedent-pronoun relationship does not seem to represent "backward" anaphora in any linear fashion.

There is, however, another way in which we can capture what is unusual about the coreference relationship in (44a), and that is in terms of syntactic rank. In section 2.1, I examined the idea that lower-ranked arguments are prohibited from being questioned over higher-ranked arguments; in particular, this was the principle invoked to block examples of strong crossover (45a). In keeping with Wasow's point, the corresponding cataphoric declarative (45b) is equally bad under the marked reference relationship.

- (45) a. *Who_i does Mary think he_i kicked?
 b. *Mary thinks someone_i kicked Charlie_i.

¹⁵While it seems to me that (44b) is actually easier to interpret than the corresponding WCO example, Wasow's observations ring true insofar as (44b) is more difficult to resolve than (iib) in the same way that (44a) is more difficult to interpret than (iia):

- (ii) a. Who_i greeted his_i mother?
 b. Someone_i greeted his_i mother.

However, the “badness” of (45b) might also be explained by the fact that, under the marked reference relationship, the embedded object is functioning as an antecedent to the embedded subject. That is, in both (45a) and (45b) we have an object acting as antecedent to a coreferent subject. It seems to me that, absent any clear reason that this is incorrect, we may as well characterize the “cataphora” problem via syntactic rank. This is supported by the following examples:

- (46) a. *Someone_i, Mary thinks he_i kicked.
 b. Someone_i, Mary thinks kicked himself_i.
- (47) (*)/?Someone_i, his_i mother greeted.

In parallel with the earlier characterization of syntactic prominence in extraction, we find that topicalization of an (embedded) object over a coreferent pronominal subject (46a) is as bad as its non-topicalized counterpart; on the other hand, topicalizing a subject over a coreferent pronominal object is entirely unproblematic. Crucially, the topicalized variant of (44), (47) does not seem to be ruled out; rather, just like the WCO case it corresponds to, the coreference relationship seems to be somewhat “muddy” compared to the clear-cut ones in (46).

Although these data may equally well be used to justify a transformational/movement theory of *wh*-fronting and/or topicalization, I take this to suggest that the coreference relationships involved in WCO sentences are difficult (or cognitively taxing) for the same reason that the extractions involved in WCO are: they involve an underspecified relationship of syntactic rank (e.g. between a subject-contained possessive pronoun and an object argument). Moreover, this view provides us with a means of accounting for the parallel between WCO and cataphora data that captures Wasow’s original suggestion that WCO is variable while strong crossover (and associated cataphora) are simply ungrammatical; on this view, it is not because the configuration of the coreference relationship is identical in the declarative and interrogative structures, but because the same elements (with respect to syntactic function) are involved.

If this is correct, then any improvements that can be made with respect to the coreference relationship in WCO examples should equally well “improve” the corresponding cataphora, but *only insofar* as the elements contributing to the improvement are otherwise present in both sentences. This prediction is important in light of the following data:

- (48) a. (*)/?Who_i did his_i clients dislike?
 b. Who_i did only his_i clients dislike?
 c. Who_i did even his_i clients dislike?
- (49) a. (*)/?His_i clients hated someone_i.
 b. (*)/?Only his_i clients hated someone_i.
 c. (*)/?Even his_i clients hated someone_i.

The examples in (48) are Postal’s (1993) data including focus adverbials, repeated from the introduction. As previously noted, where (48a) is questionable in the manner of the other

WCO examples we have considered, the focus-particle-containing examples, (48b) and (48c) are completely acceptable. The same effect does not seem to hold for the examples in (49), however: while (49a) is roughly equal to (48a) in terms of acceptability, including the focus adverbials *even* and *only* (examples 49b-49c) does not noticeably improve them. Whatever theory we provide for the focus improvements to the WCO examples, then, will ideally also provide an explanation for the fact that declarative (canonical) cataphoric coreference is not similarly improved.

I would like to suggest that the distinction between the examples in (48) and those in (49) is key to understanding how focus improves the parseability (and therefore the acceptability) of WCO sentences. The most immediate difference between the two sets of examples is that (48) are questions, while (49) are declaratives: more specifically, the examples in (48) contain *wh*-operators and the others do not. On most semantic theories of questions, *wh* words are associated in some way with a focus-type semantics, insofar as they invoke sets of alternatives which function as potential answers to the question (Hamblin 1973, Karttunen 1977, Groenendijk and Stokhof 1984, von Stechow 1989). Consequently, the examples in (48b)-(48c) each involve two focus-sensitive elements: the *wh*-operator in addition to a focus particle, while (49b) and (49c) have only the latter. This, I suggest, is the reason that focus adverbials are able to improve WCO sentences: roughly speaking, the two focused elements are “put together,” making coreference between them highly salient and (relatively speaking) less cognitively taxing, despite the cataphoric configuration of antecedent and anaphor. More precisely, I propose that the presence of two focus elements allows each element to constrain the set of alternatives invoked by the other (cf Rooth 1985, 1992).

Before pursuing the details of such a proposal, I present for brief consideration some additional data which seem to me to suggest that an account along the lines sketched above is on the right track. The idea is that it is the presence of *even* or *only* as a *second* focus-sensitive element that produces the observed improvements in (48b) and (48c), and not their specific lexical (truth conditional or presuppositional) contribution. The first prediction that this makes is that the same mitigating effect should be achievable with other focus adverbials (and, indeed, other means of invoking focus alternatives in what we might call the body of the *wh*-question). The examples in (50) test this with the syntactically parallel focus adverbials *just*, *especially*, and *at least* (see König 1991, for a more complete list of focus particles, and discussion of their syntactic idiosyncrasies).

- (50) a. (*)/?Who_i did his_i clients dislike?
 b. Who_i did just his_i clients dislike?
 c. Who_i did especially his_i clients dislike?
 d. Who_i did at least his_i clients dislike?

Any conclusions based on this narrow data set are entirely preliminary, but it seems to me that (50b)-(50d) represent the same sort of improvement to the “bare” WCO sentence (50a) as (48b) and (48c) do.

The outlined proposal makes another prediction as well, which can also be subjected to a quick test. Note that the relevance of the *wh*-operator to the coreference relationship is

that, like a focus element, it introduces alternatives. We should therefore be able to achieve the same mitigation of cataphoric coreference by substituting another focus construction for the interrogative, and retaining the focus adverbial. The examples in (51) use clefting constructions to do this; compare (51) to the topicalized examples in (52), which do not introduce a second focus element.

- (51) a. (*)/?It was someone_i his_i clients disliked.
 b. It was someone_i only his_i clients disliked.
 c. It was someone_i even his_i clients disliked.
- (52) a. (*)/?Someone_i, his_i clients disliked.
 b. (*)/?Someone_i, only his_i clients disliked.
 c. (*)/?Someone_i, even his_i clients disliked.

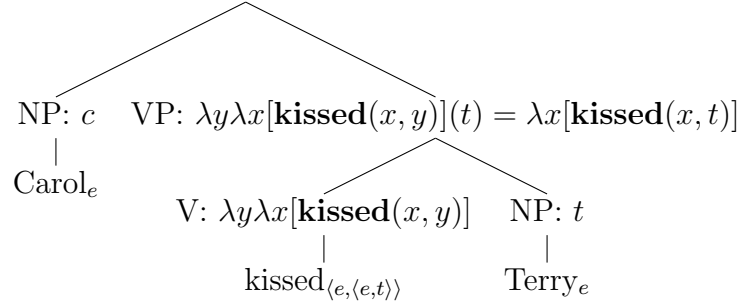
At this level of inspection, it seems that the “bare” clefted example in (51a) is roughly comparable in acceptability to both the bare WCO example (50a) and the bare topicalized example (52a). However, the clefted structures that contain focus particles, (51b) and (51c), do seem to represent an improvement over (51a), but the same is not true for the particle-containing topicalized examples (52b)-(52c), with respect to (52a). At least at a superficial level, then, it appears to be true that it is the presence of two focus elements in the improved WCO sentences (48b)-(48c) that facilitates resolution of the cataphoric coreference relation – and not solely the modification of these sentences with the adverbials *even* or *only*.

3.2.2 An overview of focus semantics

In developing this proposal, I will rely on Rooth’s (1992) theory of focus semantics, and, in particular, on his proposal for the effect of contrastive focus. His theory is based on a notion of *alternative semantics*, developed by Jacobs (1983, 1988), Rooth (1985), Kratzer (1991), and others.

A compositional theory of semantics builds the meanings of phrases from the individual (functional, variable, or referential) meanings of their components in a systematic way: through applications of variably complex functions to objects of the right type for them to take as arguments. Roughly speaking, a simple sentence like (53a) will involve two iterations of function application: one where a (schonfinkelized) two-place function represented by the verbal predicate *kissed* (of the type $\langle e, \langle e, t \rangle \rangle$, which takes an individual to a function from individuals to truth-values) takes the object *Terry* (of type e , an individual) as its argument, and a second where the one-place function thus produced takes the subject *Carol* (also type e) as its argument.

- (53) a. Carol kissed Terry. b. S: $\lambda x[\mathbf{kissed}(x, t)](c) = \mathbf{kissed}(c, t)$



As shown in (53b), this builds up the value $\mathbf{kissed}(c, t)$ for the meaning of the proposition (53a), which will (ultimately) be given a value of *true* if and only if the pair (c, t) (Carol and Terry) turn out, in the world of evaluation, to belong to the set denoted by \mathbf{kissed} , which is something like the set of all ordered kissing-pairs from our relevant domain E of individuals.

In addition to the value $\mathbf{kissed}(c, t)$, which he refers to as the *ordinary semantic value* of a sentence (53a), Rooth (1992) proposes that focus can (optionally, if present) associate a semantic element with an additional value, which he calls its *focus semantic value*. For a full proposition containing a focused element, the focus semantic value comprises a set of propositions – specifically, it is just the set of propositions obtained by making substitutions for the focused element over available elements of the same type. For instance, if our (relevant) domain of individuals E contains Jordan and Gail (j and g) in addition to Carol and Terry (c and t), focusing *Carol* in the proposition (53a) will produce the ordinary semantic value shown in (53b), but the focus semantic value given in (54a). On the other hand, focusing *Terry* will produce the ordinary semantic value (53b), and the focus semantic value (54b).

- (54) a. $\llbracket \text{Carol}_{\text{FOC}} \text{ kissed Terry} \rrbracket^f = \{\mathbf{kissed}(c, t), \mathbf{kissed}(g, t), \mathbf{kissed}(j, t), \mathbf{kissed}(t, t)\}$
 b. $\llbracket \text{Carol kissed Terry}_{\text{FOC}} \rrbracket^f = \{\mathbf{kissed}(c, c), \mathbf{kissed}(c, g), \mathbf{kissed}(c, j), \mathbf{kissed}(c, t)\}$

Crucially, the ordinary semantic value is always a member of the focus semantic value. This remains the case even when the informal definition of focus semantics given above is extended in order to apply to predicates like *kissed* as well as subsentential phrases (Rooth 1985, Kratzer 1991). What precisely the semantics (and/or pragmatics) does with the focus semantic value varies based on the presence or absence of focus-sensitive elements in a formula, but as a rough approximation, we can say that focus seems to highlight the ordinary semantic value in some way from amongst a particular set of relevant alternatives.

According to most theories of their meaning, the particles *only* and *even* are focus-sensitive; that is, they perform some operation on the focus semantic values of the constituents they modify, as well as upon the ordinary semantic value. What is particularly interesting about focus particles of this type is that they can “bridge” between the focus semantic value of a constituent ϕ and the ordinary semantic value of a constituent containing ϕ as a subpart (König 1991). For instance, *only* is widely regarded to make a truth-conditional contribution over the focus semantics of its complement. (55) provides a first pass at a Rooth-style semantics for *only*.

- (55) Let x be the *only*-complement, R the “background” predicate, and C (a subset of) the focus semantic value of x , $\llbracket x \rrbracket^f$. Then:
 $\mathbf{only}(x)(R) = R(x) \wedge \forall y \in C[R(y) \rightarrow y = x]$

For (56), then, with focus on *Carol*,¹⁶ the addition of *only* conveys not only the truth conditions that $\mathbf{kissed}(c, t) = 1$, but also that the proposition “ x kissed Terry” is false for any non- c member of Carol’s (restricted) focus semantic value, $\llbracket \text{Carol} \rrbracket^f$.

- (56) $\llbracket \text{Only Carol}_{\text{FOC}} \text{ kissed Terry.} \rrbracket$
 $= \mathbf{only}(c)(\lambda x. \mathbf{kissed}(x, t))$
 $= \lambda x. \mathbf{kissed}(x, t)(c) \wedge \forall y \in \llbracket \text{Carol} \rrbracket^f [\lambda x. \mathbf{kissed}(x, t)(y) \rightarrow y = c]$
 $= \mathbf{kissed}(c, t) \wedge \forall y \in \{c, g, j, t\} [\mathbf{kissed}(y, t) \rightarrow y = c]$
 $\rightsquigarrow \textit{Carol kissed Terry, and no one else kissed Terry}$

Even, on the other hand, seems to enter focus semantic information into a not-at-issue dimension of meaning (cf Potts 2005). On one analysis (in the spirit of Horn 1969, Fauconnier 1975b,a, Karttunen and Peters 1979, Kay 1990), $\mathbf{even}(x)(R)$ contributes identical at-issue content to $R(x)$, but (a) presupposes that some non- x alternative y satisfies $R(y)$, and (b) conventionally implicates that x is the minimal element on a contextually-determined ordering¹⁷ of its alternatives’ likelihood to satisfy R .

- (57) a. Assertion: $\mathbf{even}(x)(R) = R(x)$
b. Presupposition: $\exists y \in \llbracket x \rrbracket^f$ s.t. $y \neq x \wedge R(y) = 1$
c. CI: $x = \min_{y \in \llbracket x \rrbracket^f}^{\text{likelihood}} R(y)$

For the domain E described earlier, containing Carol, Gail, Jordan, and Terry, this gives the following:

- (58) $\llbracket \text{Even Carol}_{\text{FOC}} \text{ kissed Terry.} \rrbracket$
a. Assertion: $\mathbf{kissed}(c, t)$
 $\rightsquigarrow \textit{Carol kissed Terry}$
b. Presupposition: $\exists y \in \{c, g, j, t\}$ s.t. $y \neq c \wedge \mathbf{kissed}(y, t)$
 $\rightsquigarrow \textit{Someone other than Carol kissed Terry}$
c. CI: $c = \min_{y \in \{c, g, j, t\}}^{\text{likelihood}} \mathbf{kissed}(y, t)$
 $\rightsquigarrow \textit{Out of all of the people who might have kissed Terry, Carol was the least likely}$

¹⁶I am glossing over a number of details of the syntactic and scopal behavior of *only* (see König 1991). Crucially, *only* and other focus particles do not assign focus, but rather are sensitive to existing focus structure on their complements. For current purposes, it is enough to make the simplifying assumption that, in the absence of prosodic/intonational focus, a focus particle invokes alternatives to the full XP that it sits on the left edge of, abstracted over the (variable) element immediately to its right.

¹⁷See Löbner (1989), König (1991) for a more detailed discussion of scalar particles, and Horn (1972), Fauconnier (1975b), Hirschberg (1985) for a more general discussion of pragmatic scales.

(55) and (57) and the corresponding examples (56) and (58) are very rough sketches of the semantic contributions of the focus particles in question. Nevertheless, they will suffice for current purposes: the crucial point is that, in both cases, the alternative set to the focused element, (*Carol*, in examples 56 and 58) is brought into consideration for some aspect of meaning. For the WCO cases I am investigating here, what this means is that a set of alternatives to the anaphor is brought into consideration: I take it as given that, in the absence of clear prosodic or intonational focus, applying a focus particle to the subject NP constituent, as in Postal’s examples, results in the possessive pronoun *his* receiving focus marking.

If we assume that an anaphor does something like pick out a variable in a model, then alternatives generated over a pronoun will be other possible variables. If we take it, further, that an assignment of variables to individuals is fixed in a world of evaluation, then the focus semantic value for the relevant NP in Postal’s examples is given by (59).

$$(59) \quad \llbracket \text{his}_{\text{FOC}} \text{ clients} \rrbracket^f = \{x\text{'s clients} \mid x \in E\}$$

It is worth noting that the focus semantic value, *a la* Rooth, is properly thought of as a superset (or the maximal possible value) of the set of alternatives under consideration in a given situation. Various aspects of context, syntactic features, etc, can serve to limit the actual set of alternatives under consideration in different ways. For instance, in (59), the syntactic feature of gender (male) on the pronoun will limit the actual set of alternatives under consideration in (59) to those variables which are assigned to male individuals. Crucially, while this may involve more variables than there are male individuals, the only (legal) top-level resolutions will be those which pick out male individuals.

In sentences like Postal’s, the other point at which alternatives are introduced is through the interrogative form. Hamblin-style analyses of the semantics of question attribute this to the presence of a *wh*-operator: e.g. *who* denotes a set of all discourse-relevant human individuals. On this view, the semantic denotation of a question is the set of its possible answers, through abstraction over the argument position occupied by the *wh*-element (see also Karttunen 1977).

Suppose again that our universe contains four individuals: Carol, Gail, Jordan, and Terry. Suppose also that we are standing at a window and can see the silhouette of a solitary figure at a short distance. In this context, the Hamblin meaning of (60a) would be the set of propositions given in (60b).

- (60) a. Who is in the garden?
 b. **{in-the-garden(*c*), in-the-garden(*g*), in-the-garden(*j*), in-the-garden(*t*)}**

Put in Roothian terms, the contribution of a *wh*-element in a question like (60a) is to make the ordinary semantic value of the whole sentence equal to the focus semantic value of a corresponding answer – i.e. one in which focus is on the individual that replaces the *wh*-word in an appropriate answer. As before, the actual set of alternatives under consideration can be restricted downwards: if we can, for instance, see that the silhouette has long hair, and furthermore know that Jordan and Terry are the only long-haired individuals in *E*,

we can immediately restrict the ordinary semantics value of (60a) to the two-member set $\{\mathbf{in-the-garden}(j), \mathbf{in-the-garden}(t)\}$.

Recasting in these terms brings out an important analogy between focus and question semantics. In particular, while the Hamblin analysis is an elegant integration of (certain types of) interrogatives into a Montagovian framework (Montague 1970a,b, 1973), a question seems to do something more than simply present a set of possible answers – it solicits information relative to those answers.¹⁸

I noted earlier that, in addition to introducing an alternative set, focus does something like mark one of the elements of this set as having special status. For a declarative, the “special” value is simply the ordinary semantic value. We might think of question alternatives as containing a highlighted element as well: in particular, the question form conveys that one of its possible answers has the special status of being the correct one – in this case, however, the speaker does not know which (but it is at least implied that the interlocutor does). Put another way, a question can be thought of as simultaneously presenting a set of alternative propositions and requesting an interlocutor to identify which of the admissible alternatives is the correct one (see also Lauer and Condoravdi 2012, on interrogatives). Generally speaking, focus seems to have a close connection to the question-answer relation (Groenendijk and Stokhof 1984); it is very natural for a declarative like (61b) to be interpreted as answer to the (implicit) question (61a). Similarly, we often understand a term-answer such as “Carol” to the question (61a) as elliptical for the focused declarative (61b).

- (61) a. Who is in the garden?
b. Carol_{FOC} is in the garden.

At this point, the picture we have is as follows: a *wh*-question invokes a set of alternative propositional answers, and conveys that one of these is special (and, implicitly, that the interlocutor is supposed to know which one this is). At the same time, focus on a pronominal element generates a set of alternatives over its variable assignment, again with the information that one of these alternative is special. In building up (compositionally) a representation of the meaning of a WCO sentence, we need to build up a question-denotation (i.e. set of top-level alternatives) that takes into account the focus marking on the pronominal.

One way of treating the denotation of pronouns assumes that they are fixed (in logical form) to some particular variable in a model. This makes a certain amount of sense from the point of view of a speaker, since presumably we know our intended referents when we produce a sentence. It is helpful here, however, to consider the point of view of an interlocutor: the choice in some sense is restricted to the gender-agreeing individuals in the relevant domain (see also Mayr 2010). On this end, the set can be narrowed down by considering cues in the structure or context – such as, e.g. focus structure.

Consider a pronoun-containing interrogative such as (62):

¹⁸We might try to relegate this to a strictly pragmatic aspect of meaning, but given that it is in a sense hard-coded into the meaning of a question (in terms of both syntax and lexical insertion), it seems more reasonable at this stage to assume it belongs to a dimension or aspect of meaning along the lines of Pott’s (2005) *conventional implicature*.

(62) Who did he see?

As the addressee in a discourse context, we have a certain amount of information available to us, put together from context and (syntactic and semantic) structure. For one, immediate discourse context makes certain individuals more salient as potential referents for a pronoun. In addition to this, we can use pronoun gender features to narrow down the list of possibilities to just the salient individuals who are also male. We also know, from the use of the *wh* word and interrogative form, that we are being presented with a set of alternatives from which our interlocutor presumes that we can identify the correct world description. This might invoke something like reliance on our particularized knowledge – e.g. about information we might have that our questioner does not. In the case of a question like (62), we probably also use something like Chomsky’s (1981) Binding Principle B (“pronouns must be free in their minimal category”), or the syntactic prominence constraint on cataphora (suggested earlier), in order to rule out readings on which the *who* and *he* are coreferent. Roughly speaking then, we can use this information to restrict the set of potential answers down to those in which (a) subject and object are distinct and (b) the referent possibilities for the subject are both male and contextually salient. If everything has gone well, from a cooperative/communicative standpoint, at this point we should not only be able to resolve the pronoun’s referent, but also we should find that the list of answers has been narrowed to the point that we can easily pick out the correct world description.

In the Postal cases, we get a slightly different set of tools. As before, we can restrict the set of referents for the possessive pronoun *his* to male individuals, and (given a discourse context), we presumably also know which of these are most discourse-salient. The interrogative form again carries the presumption that we (as the addressee) know which answer choice is the special one.. In this case, however, the coreferenced readings are not ruled out on syntactic principles. In general, we might suspect that there is a tendency to select a referent from the discourse context rather than the syntactic context (as it were), since coreference will require calculating something that looks a lot like a dependency crucially *while* the *wh*-element is being held in working memory (i.e. before the extraction is resolved). Under these circumstances, assigning the pronoun variable to something “new” (with respect to the sentence) is probably the easiest cognitive move. However, focus can change this. In the *even* and *only* examples from Postal, I suggest that focus actually provides a reason – from efficiency – to override any natural tendency to avoid coreference. For one, the pronoun is given the same information structure marker as the *wh*-word, which automatically suggests a link between the two. In addition, a *wh*-word is naturally marked as containing the “new” or sought-for information in an interrogative – marking the possessive pronoun with focus as well might easily suggest a connection to this information. In a sense, what we have is two classes of choice for building up our top-level representation of the question’s denotation. We might on the one hand introduce a new (at least, new within-sentence) referent for the pronoun, giving us a set of alternatives with the cardinality of the cartesian product of the *wh*-alternatives and the pronoun’s alternatives – and, in addition, we will need another contextual reason to justify the focus marking on the pronoun. Alternatively, we might utilize the shared marking that already exists on pronoun and *wh*-operator to identify them: this

gives us a readymade reason for the focus structure, and dramatically reduces the set of alternatives under consideration. I will not present a fully formalized account of how such a process occurs at this time, but it seems to me that the dual focus marking essentially serves to make coreference highly-salient, as well as more efficient to process and respond to. It is not necessarily that establishing a coreference “dependency” is objectively computationally less complex in the focus case than the non-focus case, but rather that it is suggested by the fact that both *wh*-operator and possessive pronoun are pushed into the focus side of any computation – that is, we are forced to work out a relationship between them regardless of coreference, and coreference at this point can only simplify our task. Crucially, this hypothesis does not suggest that focused examples are immune to non-coreferent interpretations of their pronouns, but rather that the shared reference can be made highly salient by focus – a process presumably also aided by features of the discourse context that lead the questioner to use focus (and the particular focus-invoking construction or lexical item that he chose) in the first place.

4 Focus improvements to weak crossover

In this section, I report on the results of an experimental study designed to measure the effect of focus manipulations on WCO sentences. At its most basic, the goal of this study is to demonstrate that associating the possessive pronoun in WCO sentences with focus does, in fact, improve empirical judgements about the grammaticality of WCO sentences. Beyond the intuitions described in Postal (1993) and reiterated here, there is no demonstration in either the crossover or information structure literature that the effect is real.

If the focus improvement effect is empirically supported, this provides good evidence for the central view defended and elaborated on in this paper – namely, that WCO “violations” are not, in fact, grammatically out. Secondly, I hope to demonstrate that pragmatic reasoning and information structure have a material impact on processing considerations, which interacts with judgements of acceptability (in the way suggested by Hofmeister 2007 and Hofmeister and Sag and 2010). Beyond this, I hope to shed some light on the mechanisms by which focus manipulations achieve alleviating effects, which can provide a basis on which to further formalize the rough theory outlined in the preceding section.

4.1 A note on methodology

One of the central issues in any study of coreference phenomena, and of crossover in particular, is a purely methodological one. A critical feature of a WCO sentence is that it is only problematic (loosely speaking) under a specific coreference reading. Thus, (63a), where *her* and *who* are indexed distinctly is never unacceptable, but (63b), where they are marked as coreferent is, at least potentially.

- (63) a. Who_{*i*} did you give her_{*j*} book to?
b. Who_{*i*} did you give her_{*i*} book to?

In eliciting acceptability judgements of WCO sentences, therefore, it is crucial to find a means of communicating the intended coreference structure. While the index method (used above) is one way of so doing, it introduces some potentially serious confounds. First, it would (presumably) require explanation, for naïve informants; secondly, this explanation runs the risk of, at worst, inducing bias by making the question of research transparent to experimental participants, or, at least, introducing an undesirable level of reflection and/or introspection about coreference possibilities in general. Generally speaking, it is preferable to avoid (however tangentially) predisposing informants to a “theorizing” mindset; the question is, therefore, how to elicit acceptability judgements about WCO without obviating the need to seek non-linguistically trained informants in the first place.

In Nadathur (2013), I employed the following method of questioning in a non-experimental setting. Informants were shown a prompt along the lines of (64a), and asked to answer the question in (64b) to the best of their ability.

- (64) a. *A asked B*: “Who did you give her book to?”
 b. *By the phrasing of the question, which of the following could B have given the book to: the book’s owner, someone besides the book’s owner, or either?*

As a response, “the book’s owner” corresponds to the WCO reading, while “someone else” corresponds to the unmatched indexing in (63a). Finally, the “either” response suggests that both anaphoric possibilities are left open (for the respondent) by the structure of the sentence. The respondent’s choice should, ideally, indicate which of the possible reference relationships are acceptable, but this paradigm does not involve asking directly about either grammaticality or coreference. This basic methodology is adopted in the studies described here, with some minor modifications, as detailed below.

4.2 Pilot studies

4.2.1 Experiment I: Design

In a first pilot study, participants were presented with short scenarios and asked to identify the referent of a pronoun or *wh*-operator in a multiple-choice condition. The scenarios set up potentially relevant discourse referents and provided context for the target sentences, which represented either embedded WCO questions (test conditions) or an ambiguous pronoun (in filler conditions). Participants saw 12 trials each, five of which were selected from nine total test scenarios, and the remaining seven of which were drawn from a collection of fillers.

Test trials were randomly assigned to one of three conditions: *null*, *pronoun-focus*, or *NP-focus*, as shown in the example in (65).

- (65) A number of local businesses took a serious interest in this year’s political campaigns, with some businessmen even running for office.
 a. *Null*: One executive asked who his business partners had endorsed for mayor.
 b. *Pronoun-focus*: One executive asked who only his business partners had endorsed for mayor.

- c. *NP-focus*: Only one executive asked who his business partners had endorsed for mayor.

In the null condition, coreference between the *wh*-operator and the pronoun involves a WCO “violation.” The pro-focus condition includes the focus adverbial *only*, modifying the pronoun, but is otherwise identical to the null condition. In the NP-focus condition, the matrix noun phrase is the one modified by *only*.

After reading a short scenario such as (65), participants clicked a button to reveal the associated multiple choice question. (66) was paired with the example scenario above:

(66) *Based on the paragraph above, select the best answer to the question in bold.*

Who could the executive have been asking about?

A: A candidate who the executive’s partners had endorsed.

B: A businessman who was endorsed by his own partners.

C: Either A or B.

In this example, the coreferenced reading is the B option, but the order of coreferring and non-coreferring answers was varied at random throughout the trials. Participants were required to select an answer before continuing to the next question.

A sample filler, and its associated multiple-choice question are given in (67)-(68):

(67) The new chef was having a very hard evening. One fussy man had sent back his appetizer, and a woman had complained that the soup was cold. Nobody realized how hard he was working to make a good impression on everyone.

(68) *Based on the paragraph above, select the best answer to the question in bold.*

Who was trying to make a good impression?

A: The chef.

B: The man who sent back the appetizer.

C: Either A or B.

125 participants were recruited to take part in this pilot study, via Amazon’s Mechanical Turk platform. All were financially compensated for their participation, regardless of language status. Linguistic data (native and other languages spoken) was collected from all participants after their completion of the study; non-native speaker data was dropped prior to analysis, leaving a total of 124 participants’ data. The pilot study can be viewed at web.stanford.edu/~pnadath/experiments/WCO.html.

4.2.2 Experiment I: Predictions

If the central argument of this paper is correct, then we expect some baseline availability of the coreferenced response in all test conditions. Thus, we expect that a nonzero number of participants will select one of the two WCO-permitting responses; either the WCO-only

answer (B in 66), or C. A WCO-permitting response rate at (or statistically equivalent to) zero in all test conditions (including pro-focus) would, on the other hand, support the claim that WCO is categorically out, although it would not comprise direct proof of this claim.

The literature (such as it is) on focus improvements and the intuition associated with pairs like (12a) and (12c) suggest that the pro-focus condition should not only increase the permissibility of WCO interpretations over the rate observed in the null condition, but also may render the WCO-only interpretation more salient than the non-coreferenced reading. Overall, then, we predict a statistically significant increase in WCO-permitting responses from the null condition to the pro-focus condition; if the inclusion of *only* does privilege WCO, we predict additionally a positive shift in the ratio of these responses that come from the WCO-only answer vs the “either” option.

The NP-focus condition, ideally, will shed some light on this second point. In the previous section, I suggested that focus (essentially) privileges the coreference relationship over one in which the pronoun is assigned to a new referent. In the stimuli developed for this experiment, each target sentence contains a salient and legal antecedent for the pronoun which is not possibly coreferent with the antecedent (i.e. the element that gets focused in the NP-focus condition). If the hypothesis about focus-identification is correct, the pro-focus cases should show a preference for coreference *over* the available salient alternative. On the other hand, in the NP-focus condition, we should not expect an improvement in WCO-readings.

4.2.3 Experiment I: Results and discussion

Raw results from the first pilot study are included below. Figure (1) represents the percentage of responses of each type. *Both* here represents the C answer – i.e. the percentage of respondents who interpreted the embedded question as plausibly referring to either A or B referent. The middle group (*No WCO*) represents the percentage of participants who did not generate a WCO interpretation, and the right-hand group (*WCO*) is the percentage of participants who selected the WCO-only interpretation. The red bars in each group represent responses in the null condition (no focus particle), while the green represents the NP-focus condition and the blue represents the pro-focus condition. Error bars represents 95% binomial confidence intervals. Numerical data is given in Table (1).

Table 1: Percentage of both, non-WCO, or WCO-only readings, by condition

<i>Condition</i>	<i>N</i>	<i>% BOTH</i>	<i>% No WCO</i>	<i>% WCO-only</i>
null	197	34.52 ± 6.64	42.13 ± 6.89	23.35 ± 6.91
NP-focus	224	26.79 ± 5.80	51.34 ± 6.55	21.88 ± 5.42
pro-focus	199	26.13 ± 6.10	42.71 ± 6.87	31.16 ± 6.44

These aggregated results show, first of all, that WCO readings are available, even in the absence of a focus particle; the red bar is at or above 20% in both the left- and right-hand groups. Secondly, focusing on the rate of WCO-only responses (right group), the pilot

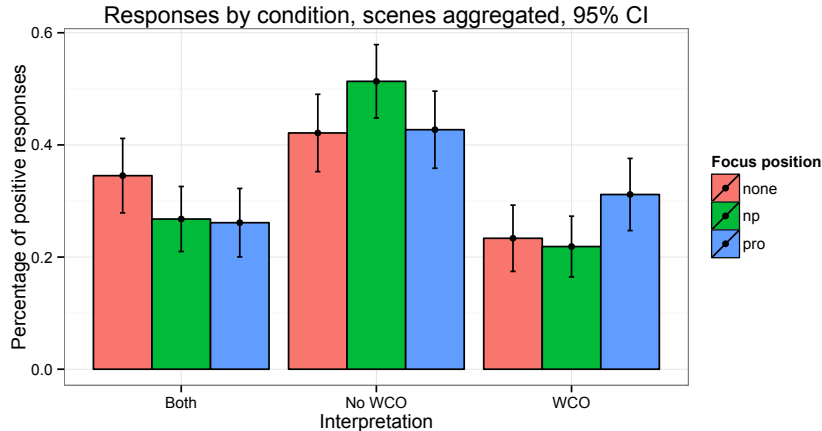


Figure 1: Percentage of both, non-WCO, or WCO-only readings, by condition

results show that WCO-only readings increase significantly when *only* modifies the pronoun (although the binomial confidence intervals of the red and blue bars do overlap in the right-hand group, this overlap does not include the midpoint of either interval). Finally, again in the right-hand group, we observe a slight dip in the response rate for WCO-only readings going from the null (red) to the NP-focus (green) condition. While this is not a significant difference, it is notable that the percentage of “both” responses (left-hand group) decreases significantly moving from the null to NP-focus condition, which suggests that there is some overall effect of this shift.

On the whole, however, results from this pilot were inconclusive and suggested the need to control a number of additional variables. This is demonstrated in part by the high variability of the “by scene” results given in Figures (2)-(4). Figure (2) represents the percentage of “either” responses given in each condition, broken down by the particular stimulus scenario to which the response was given; Figure (3) represents the percentage of WCO-disallowing responses by scenario, and Figure (4) the WCO-only interpretations. What emerges from these details, examined together, is that the scenario presented apparently plays a nontrivial role in the interpretation patterns associated with WCO. This is perhaps unsurprising on an account of focus and coreference that interacts with pragmatic content for the resolution of ambiguity, but makes it difficult to draw strong conclusions regarding the relationship between focus manipulations and WCO in the context of this pilot. As an example of this, Figure (4) shows the predicted increase in WCO-only responses going from the null (red) to pro-focus (blue) conditions in seven of nine scenarios, but there is no consistent way to compare the NP-focus (green) and null conditions.

Figure (4) is not an accurate representation of the rate of WCO-permitting interpretations, of course, since participants choosing the “either” option in principle also permit WCO (even if they do not prefer it). Figure (5) shows the aggregate percentage of WCO-

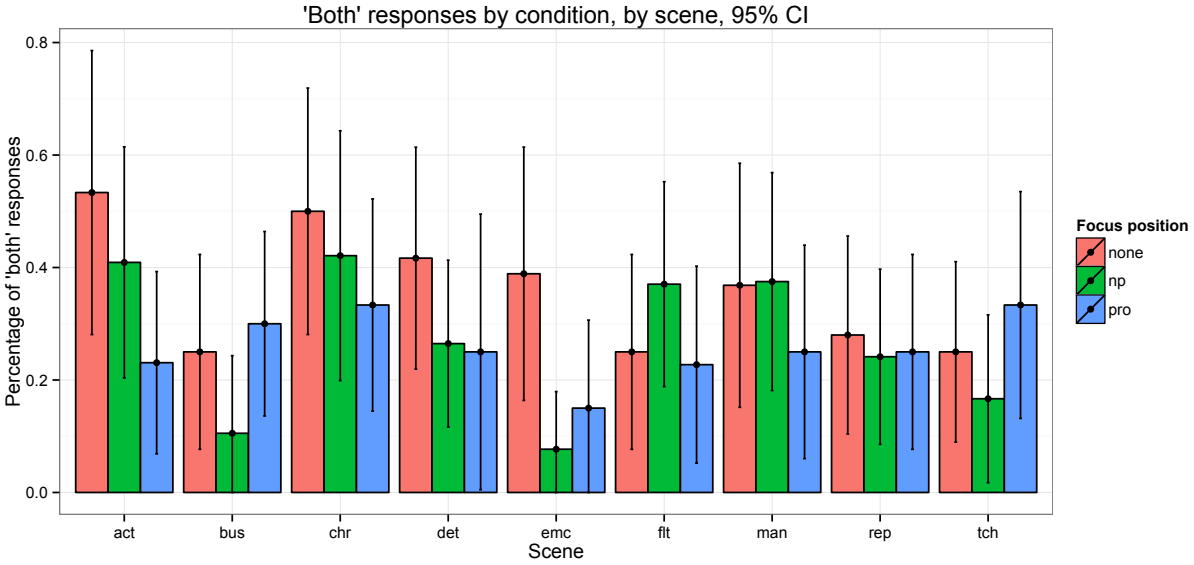


Figure 2: Percentage of respondents permitting either interpretation, split by scenario

Table 2: *BOTH* results for Pilot I, by scenario

<i>Question type</i>	<i>N</i>	<i>%both</i>	<i>N</i>	<i>%both</i>	<i>N</i>	<i>%both</i>
		<i>act</i>		<i>bus</i>		<i>chr</i>
null	15	53.33 ± 25.24	24	25.00 ± 17.32	20	50.00 ± 21.92
NP-focus	22	40.91 ± 20.55	19	10.53 ± 13.80	19	42.16 ± 22.26
pro-focus	26	23.08 ± 16.22	30	30.00 ± 16.40	24	33.33 ± 18.86
		<i>det</i>		<i>emc</i>		<i>ftt</i>
null	24	41.67 ± 19.73	18	38.89 ± 22.52	24	25.00 ± 17.32
NP-focus	34	26.47 ± 14.83	26	7.69 ± 10.25	27	37.04 ± 18.22
pro-focus	12	25.00 ± 24.50	20	15.00 ± 15.65	22	22.73 ± 17.51
		<i>man</i>		<i>rep</i>		<i>tch</i>
null	19	36.84 ± 21.69	25	28.00 ± 17.60	28	25.00 ± 16.04
NP-focus	24	37.50 ± 19.37	29	24.14 ± 15.58	24	16.67 ± 14.91
pro-focus	20	25.00 ± 18.80	24	25.00 ± 17.32	21	33.33 ± 20.16

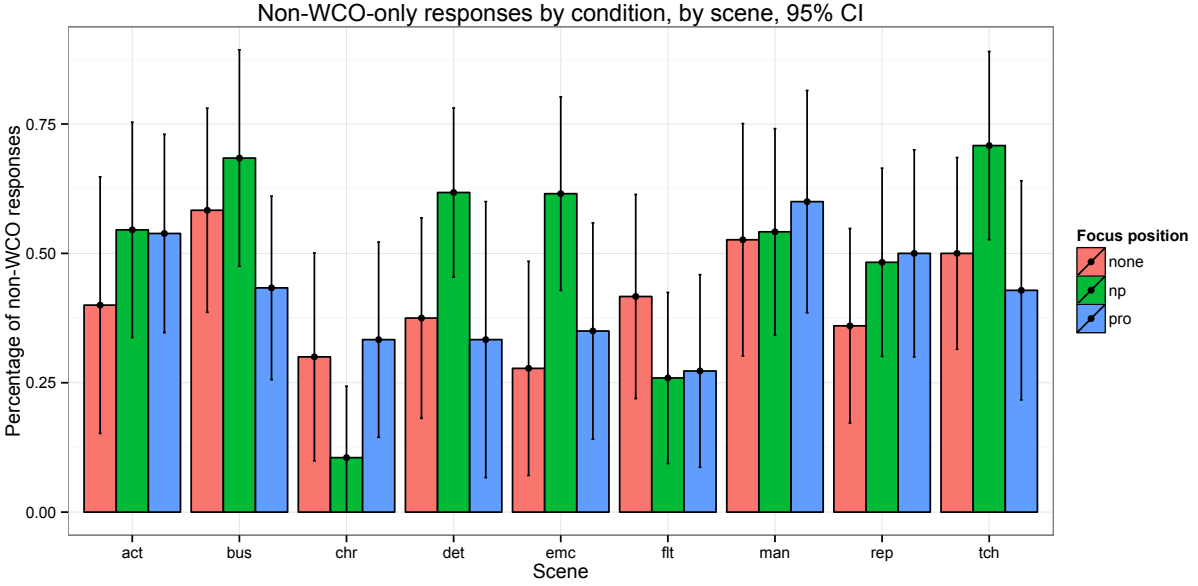


Figure 3: Percentage of respondents disallowing WCO interpretation, split by scenario

Table 3: WCO-disallowing results for Pilot I, by scenario

Question type	<i>N</i>	%No WCO	<i>N</i>	%No WCO	<i>N</i>	%No WCO
		<i>act</i>		<i>bus</i>		<i>chr</i>
null	15	40.00 ± 24.79	24	58.33 ± 19.72	20	30.00 ± 20.08
NP-focus	22	54.55 ± 20.81	19	68.42 ± 20.90	19	10.53 ± 13.80
pro-focus	26	53.85 ± 19.17	30	43.33 ± 17.73	24	33.33 ± 18.86
		<i>det</i>		<i>emc</i>		<i>ftt</i>
null	24	37.50 ± 19.37	18	27.78 ± 20.69	24	41.67 ± 19.73
NP-focus	34	61.76 ± 16.33	26	61.54 ± 18.70	27	25.93 ± 16.53
pro-focus	12	33.33 ± 26.67	20	35.00 ± 20.90	22	27.27 ± 18.61
		<i>man</i>		<i>rep</i>		<i>tch</i>
null	19	52.63 ± 22.45	25	36.00 ± 18.82	28	50.00 ± 18.52
NP-focus	24	54.17 ± 19.94	29	48.28 ± 18.19	24	70.83 ± 18.18
pro-focus	20	60.00 ± 21.47	24	50.00 ± 20.00	21	42.86 ± 21.17

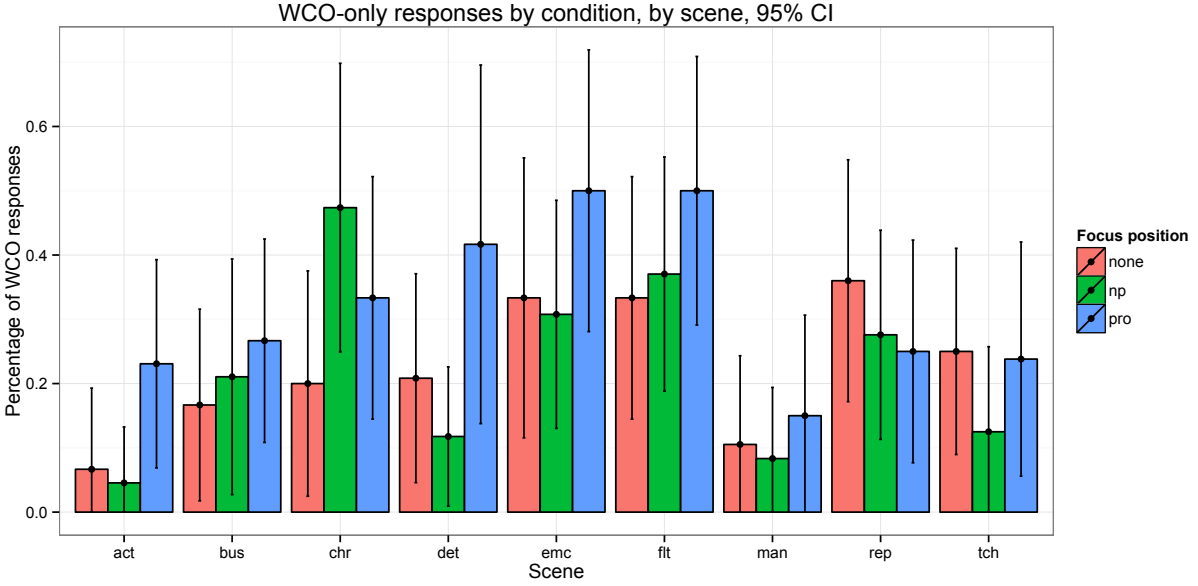


Figure 4: Percentage of respondents preferring WCO-only interpretation, split by scenario

Table 4: WCO-only results for Pilot I, by scenario

<i>Question type</i>	<i>N</i>	<i>% WCO</i>	<i>N</i>	<i>% WCO</i>	<i>N</i>	<i>% WCO</i>
		<i>act</i>		<i>bus</i>		<i>chr</i>
null	15	6.67 ± 12.62	24	16.67 ± 14.91	20	20.00 ± 17.53
NP-focus	22	4.55 ± 8.70	19	21.05 ± 18.33	19	47.37 ± 22.45
pro-focus	26	23.08 ± 16.20	30	26.67 ± 15.83	24	33.33 ± 18.86
		<i>det</i>		<i>emc</i>		<i>fit</i>
null	24	20.83 ± 16.24	18	33.33 ± 21.77	24	33.33 ± 18.86
NP-focus	34	11.76 ± 10.83	26	30.77 ± 17.74	27	37.04 ± 18.22
pro-focus	12	41.67 ± 27.90	20	50.00 ± 21.91	22	50.00 ± 20.89
		<i>man</i>		<i>rep</i>		<i>tch</i>
null	19	10.53 ± 13.80	25	36.00 ± 18.82	28	25.00 ± 16.04
NP-focus	24	8.33 ± 11.06	29	27.59 ± 16.27	24	12.50 ± 13.23
pro-focus	20	15.00 ± 15.65	24	25.00 ± 17.32	21	23.81 ± 18.22

permitting (either and WCO-only) responses, by the focus condition. Here, while the rate of WCO interpretation in the NP-focus condition is shown to be significantly lower than in the other two conditions, the differences noted earlier between the null and pro-focus condition (with respect to WCO-only interpretations) are lost. To some degree, this is because there is a shift in the balance of WCO-permitting responses; referring back to Figure (1), we can see that there is a significant difference in the percentage of WCO-only responses going from the null to the pro-focus condition, as well as in the percentage of “either” responses. These differences, crucially, are in an inverse relationship; the ratio of WCO-only to “either” responses increases going from the null to the pro-focus condition, as predicted.

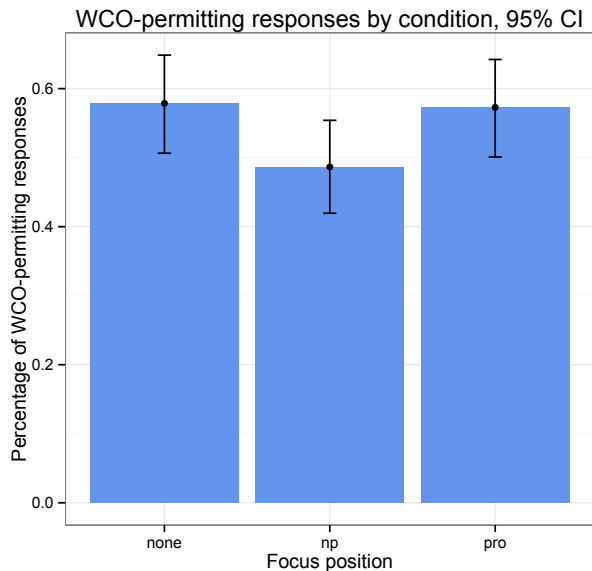


Figure 5: Percentage of WCO-permitting responses (‘both’ & ‘WCO’-only), by condition

Table 5: WCO-permitting response rate, by focus position

<i>Condition</i>	<i>N</i>	% CR responses
null	197	57.87 ± 6.90
NP-focus	224	48.66 ± 6.54
pro-focus	199	57.29 ± 6.88

While inconclusive, then, these results do serve a number of purposes. First, the results of this pilot study demonstrates with some certainty that WCO interpretations are available at a nontrivial rate under all conditions (in the aggregate in Figure 5, at 50% or above). This is strong evidence against any grammatical account which categorically rules out WCO “violations.” Second this pilot suggests that focus on the pronoun privileges WCO interpretation

over any other available interpretation, though it does not rule out the alternatives. Finally, the aggregate data in Figure (5) suggests that NP-focus does detract from the baseline availability of WCO, as predicted by the first focus-related hypothesis; however, the variability evident from the by-scene results in Figures (2)-(4) make this inconclusive. Consequently, while this pilot appears to be a successful test of the methodology outlined above, it does not represent conclusive evidence for either the baseline hypothesis (that focus improves WCO) or either of the more articulated hypotheses about focus mechanisms.

There are a number of potential reasons for this; as noted above, a tenet of the argument here is that WCO is heavily susceptible to the influence of pragmatic information. Consequently, differences in familiarity with the subject material of various scenarios, etc, could likely have had an impact on the variability evident in Figures (2)-(4). In addition to this, since the complexity of the relationships involved in WCO, any experimental study runs the risk of altering a participant’s base/naïve state of sensitivity to the availability or marginality of coreference. This was an important consideration in experimental design, and is the reason that each participant was exposed to only five test cases out of a total of fifteen trials. However, under the current version, it seems possible that including the “either” option as a possible answer may have prompted a higher degree of introspection – that is, may have led participants to consider more carefully than they would in a “real world” situation about the reference possibilities. This type of introspection may have interacted unpredictably both with focus manipulations as well as with other pragmatic factors. As noted above, the interaction between the WCO-only and “either” interpretations complicates assessment of the data. It seems likely, then, that clearer results might be obtained by, first of all, by eliminating the “either” response option.

4.2.4 Experiment II: Design

A second pilot study, also conducted on Mechanical Turk, replicated the design of the first pilot in all but two respects. Participants were presented with the same range of short scenarios as in the original study, and again were asked to identify the referent of a pronoun or *wh*-operator in a multiple-choice setting. In this version of the study, however, the “either A or B” response option was eliminated, leaving only a binary decision. Given the scenario in (65), clicking the *Show Question* button yielded the following:

(69) *Based on the paragraph above, select the best answer to the question in bold.*
Who could the executive have been asking about?

A: A candidate who the executive’s partners had endorsed.

B: A businessman who was endorsed by his own partners.

As before, participants were not able to continue from one trial to the next without selecting an answer to the current question. Due to the adjustment in response choices, the pre-experiment instructions were modified slightly from the original version. In particular, Study II participants were told to select the answer choice that “best matched” their understanding of the short passage. This phrasing was meant to suggest that, while more than

one interpretation might (on reflection) seem plausible, answers should reflect the participants' default interpretation. Study II, and the various scenarios involved, can be viewed at web.stanford.edu/~pnadath/experiments/WC010-5-15.html.

Data was collected from 125 participants, all of whom were financially compensated. In analysis, data from one participant who reported being a native speaker of a language other than English was excluded.

4.2.5 Experiment II: Predictions

As with the first pilot, the central argument predicts the availability of WCO interpretations in all three test conditions. A categorical grammatical rule banning WCO would be expected to force all respondents (statistically speaking) to choose the always-acceptable non-coreferent interpretation (answer **A** in 69). In the pro-focus condition, we expect the percentage of participants who default to a WCO interpretation to increase significantly over the null condition; this is in keeping with the idea that focus on the pronoun eases the burden of computing coreference, as well as raising the saliency of or prominence of the coreferenced resolution of the anaphor.

If focus pushes identification of the focused element and the *wh*-operator, we expect an increase in WCO readings in the pronoun-focus condition over both the null and NP-focus conditions. As before, we do not expect that the matrix subject focus should have an effect on WCO readings (compared to the null case), because identifying the *wh*-operator and matrix NP is impossible for other (contextual) reasons. We might, however, predict slightly more variability in the NP-focus cases, on the basis that interpreters may be confounded by the need to find a reason for the focus marking.

4.2.6 Experiment II: Results and discussion

Results from the second pilot study are shown in Figures (6) - (7). Figure (6) contains the composite data from all scenarios, and shows the percentage of WCO-preferring responses according to the test condition (*null*, *NP-focus*, *pro-focus*). The leftmost bar represents responses in the null condition, the middle represents responses in the NP-focus condition, and the right represents responses under pronoun-focus. Figure (7) gives the by-scenario details of Study II: each group of three bars gives the WCO response rate by condition for a given scenario. For example, the second group (*bus*) corresponds to (65) and (69). Red bars represent the null condition, green NP-focus, and blue pro-focus. Error bars in both figures are 95% binomial confidence intervals. Numerical data corresponding to Figures (6) and (7) are given in Tables (6) and (7), respectively.

In keeping with the main result of Pilot I, we see again that WCO interpretation is reliably nonzero in all conditions, including crucially the null condition. There is a slight decrease in WCO interpretation moving from the null to NP-focus condition, but this is not statistically significant: WCO interpretation rates under NP-focus are statistically equivalent to those under the null condition, and are non-zero.

The overall pattern of results deviates from Pilot I essentially in the manner predicted

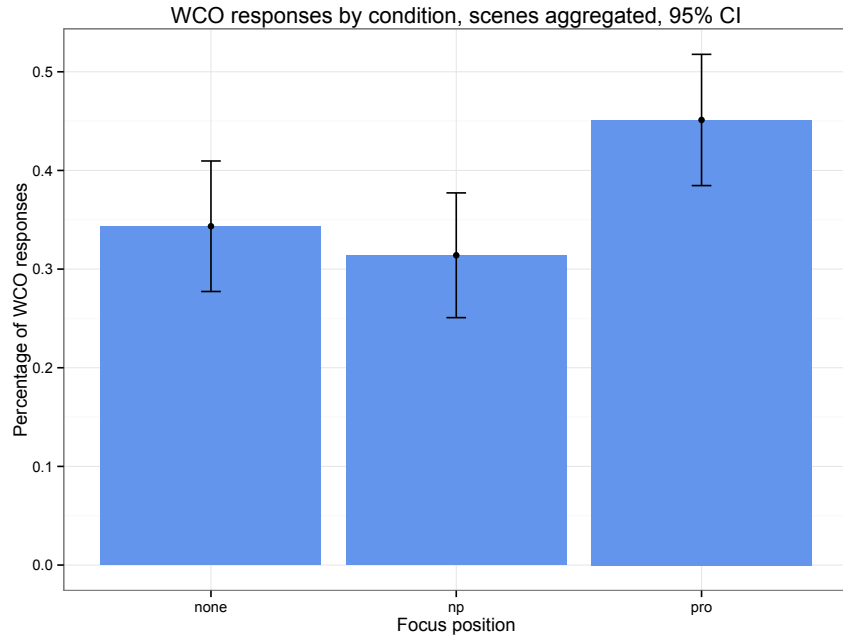


Figure 6: Percentage of WCO responses, by focus position (Study II)

Table 6: WCO-permitting response rate, by focus condition

<i>Question type</i>	<i>N</i>	<i>% CR responses</i>
null	198	34.34 ± 6.61
NP-focus	207	31.40 ± 6.32
pro-focus	215	45.12 ± 6.66

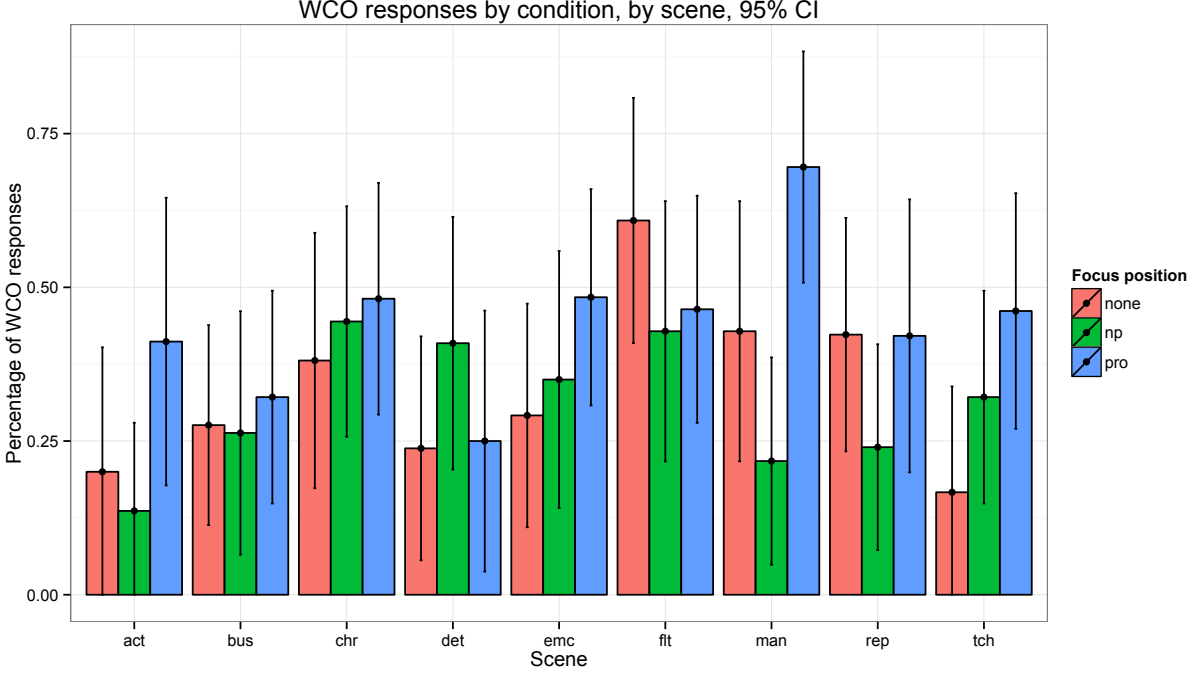


Figure 7: Study II results by scenario

Table 7: Results for Pilot II, by scenario

<i>Question type</i>	<i>N</i>	<i>% CR</i>	<i>N</i>	<i>% CR</i>	<i>N</i>	<i>% CR</i>
		<i>actor</i>		<i>bus</i>		<i>chr</i>
null	15	20.00 ± 20.24	29	27.59 ± 16.27	21	38.10 ± 20.78
NP-focus	22	13.64 ± 14.34	19	26.32 ± 19.80	27	44.44 ± 18.74
pro-focus	17	41.18 ± 23.40	28	32.14 ± 17.3	27	48.15 ± 18.85
		<i>det</i>		<i>emc</i>		<i>flt</i>
null	21	23.81 ± 18.22	24	29.17 ± 18.19	23	60.87 ± 19.95
NP-focus	22	40.91 ± 20.55	20	35.00 ± 20.90	21	42.86 ± 21.17
pro-focus	16	25.00 ± 21.22	31	48.39 ± 17.60	28	46.43 ± 18.47
		<i>man</i>		<i>rep</i>		<i>tch</i>
null	21	42.86 ± 21.17	26	42.31 ± 18.99	18	16.67 ± 17.21
NP-focus	23	21.74 ± 16.86	25	24.00 ± 16.74	28	32.14 ± 17.30
pro-focus	23	69.57 ± 18.81	19	42.11 ± 22.21	26	46.15 ± 19.16

by the design change. Contrasting Figures (5) and (6) shows that where participants in the first pilot permitted WCO interpretation at roughly equivalent rates in both null and pro-focus conditions, participants in Pilot II preferred WCO to the non-coreferenced reading at significantly higher rates in the pro-focus condition than the null condition. These figures are not directly comparable, of course, because Study I at least implicitly asked participants to consider all “legal” reference options, while Study II aimed at capturing their default preferences. What the uptick in WCO interpretations in the pronoun-focus condition of Study II does show, however, is that the rate at which participants default to a WCO reading is higher when focus associates with the embedded pronoun; this supports the thesis that focus manipulations (a) affect the acceptability of WCO “violations” and (b) that focusing the pronoun renders WCO interpretations more salient (see 12a vs. 12c). This interpretation of the results is further supported by the fact that the detailed breakdown of Pilot II results (Figure 7) shows the blue bar higher than the red one in all but two of the scenarios (the exceptions being the scenarios labeled *flt* and *rep*).

Turning to the NP-focus condition, the picture is less clear. From the aggregate results, we find the WCO interpretation rate in this condition to be statistically equivalent to that in the null condition. This tends to agree with the predictions made by the theory laid out in this paper. However, these results do not seem stable even to the limited degree that the null vs pro-focus results are: the details in Figure (7) suggest that the equivalence comes from aggregating alternation between which of the red and green bars is higher or lower across scenarios. This may be an indication of effort required to justify the use of focus marking on the matrix subject, but it could just as well indicate that eliminating the “either” response option from Pilot I is insufficient to filter out susceptibility to pragmatic “noise” (discussed in 5.2.3).

A final point worth noting is that the rate of WCO interpretation in Pilot II never exceeds 50%. Compare this to the aggregate data in Figure (5), where WCO-permitting responses exceed 50% in all conditions. This difference may not be altogether surprising when we consider that Pilot II in principle filters out a WCO-affirming response from participants who ultimately permit it but do not *prefer* it to the non-coreferenced reading. Observe, in particular, that the WCO interpretation rate in Pilot II is greater than or equal to the WCO-only rate in all conditions in Pilot I (compare Figure 6 to the rightmost group in Figure 1). However, it does not square with the intuition discussed for examples like (12), in which focus association with the pronoun seems to elevate or enhance perception of the coreferenced interpretation over any alternatives. An important consideration in this regard is that, while the questions in (12) are context-free and unembedded (that is, the non-coreferenced interpretation requires the pronoun in some sense to remain unassigned at the discourse level), the context provided for the embedded questions in Studies I and II necessarily offers an alternative discourse referent as a potential antecedent for the pronoun. This point ties into the general observation regarding the influence of pragmatics and/or world knowledge.

4.2.7 General discussion

The discussion of susceptibility to pragmatic factors (other than those introduced by information structure), as well as the demonstrated variance in the “detail” figures in section 5.2.3 and 5.2.6 prompts closer consideration of the construction of the stimulus items used in Pilots I and II. Item-by-item analysis does not reveal any immediately discernible patterns which would explain the variation between, e.g., those items for which the null condition yielded fewer WCO interpretations than the NP-focus condition, or vice versa. However, more careful consideration of world knowledge factors in certain stimuli did suggest that some of the scenarios might, in general, have pushed at baseline either towards or away from a coreferenced interpretation. An example of the latter type is given in (70)-(71), coded in the results above as *flt*.

- (70) If cabin pressure drops during a flight, and oxygen masks are needed, passengers are told to put on their own mask before paying attention to others. A recent safety drill showed that people sometimes get confused about whether to help others.
- a. *Null*: The flight attendant wanted to know who his companions ignored in the drill.
 - b. *Pronoun-focus*: The flight attendant wanted to know who only his companions ignored in the drill.
 - c. *NP-focus*: Only the flight attendant wanted to know who his companions ignored in the drill.
- (71) *Based on the paragraph above, select the best answer to the question in bold.*
Who was the flight attendant worrying about?
- A:** A passenger whose traveling companions didn’t help him.
B: A passenger who was not helped by other flight attendants.

In this case, **A** represents the WCO answer. In the null condition, (70a), WCO is rendered relatively plausible simply due to practical knowledge: anyone who has flown on a passenger airline knows that passengers are instructed to help one another (after putting on their own masks) if oxygen masks are required. Thus, a flight attendant might reasonably wish to know which passengers had failed to follow this instruction, in order to better inform them. The non-coreferenced reading, in this case **B**, is less plausible both because of the markedness of referring to other flight attendants as *companions* (instead of, e.g. *coworkers* or *colleagues*), as well as because it would be a startling dereliction of duty (or display of incompetence) for a flight attendant to have ignored a passenger in need of assistance.¹⁹ Referring to the detail data in Figure (7), we see that the *flt* scenario is the only stimulus item for which WCO interpretations were generated at greater than 50% in the baseline (null) condition.

Next, however, consider the pro-focus condition. Aside from its role as a focus-introducing adverbial (which therefore triggers the introduction of alternatives), *only* requires that the

¹⁹There is also a potential normative effect in place in this scenario; the coreferenced reading may also have been preferred in some cases due to the perception of a stereotypical flight attendant as female, generating a mismatch between the matrix subject and the male pronoun in the embedded question.

interpretation of the full sentence is false with any salient alternative substituted for the focused phrase (Horn 1969, Rooth 1985, König 1991). In other words, successful interpretation of (70) in the pro-focus condition requires that no one except the referents of *his companions* ignored the passenger in question. Unlike the scenario invoked by the null condition, this is very difficult (practically speaking) to imagine in the coreference frame: given the typical seating arrangements of airline passengers, it is tough to see how persons other than the relevant passenger’s companions (who were presumably the people seated next to him) could have done anything other than neglect him. The non-coreferenced reading is also not highly plausible here, but is a much better fit to world knowledge. This difference appears to be reflected in the data: the *flt* scenario is the only one in Figure (7) which shows a steep decrease in the rate of WCO interpretations going from the null to the pro-focus condition.

Two important points emerge from this (and parallel consideration of other stimulus items). For one, it is worth observing that reducing the practical plausibility of a coreferenced reading is evidently insufficient to eliminate it altogether: even in the pro-focus condition, WCO interpretation for *flt* rated at 46.43% (see Table 7). This supports the general conclusion drawn from Pilot I, insofar as it suggests that WCO readings are always available (and therefore not ungrammatical); moreover, it supports the thesis that associating the pronoun without focus has a positive effect on WCO interpretation, since it is ostensibly able to counteract a strong pragmatic bias against coreference.

The second – and perhaps more important – major point to take from Pilot II is that the general felicity conditions for the three test conditions are highly susceptible to contextual influence, privileging different interpretations independently of the target (*focus/only*) manipulation. This suggests that the scenarios provided as background for the embedded WCO target sentences need to be controlled carefully for both alternatives and the influence of practice/default considerations. The original studies aimed at keeping the backgrounds short in order to allow respondents a high degree of freedom in resolving reference, but the results strongly indicate that this introduces too many uncontrollable variables. Of course, it is most likely impossible to completely eliminate all pragmatic variation associated with (e.g. participants’ relative familiarity with) changing scenarios; moreover, it does not seem sensible to limit the number of scenarios in order to increase their between-item comparability. Consequently, it seems important to include a means of taking a baseline measurement of participants’ preference for the coreference/noncoreferenced interpretations of each target sentence *independently* of the complications introduced by WCO and/or focus. This is addressed in the discussion (below) of the design of the final study using *only* to introduce association with focus.

4.3 Experiment III: focus with *only*

4.3.1 Design

The overall design of this study follows the pattern of Pilots I and II: participants were presented with a text-based scenario, the last sentence of which was a target sentence containing an embedded question with a plausible WCO interpretation. As before, a *Show Question*

button revealed a multiple-choice question centered on the resolution of the pronoun’s referent, with two plausible options based on the scenario. The “either” option was not reinstated for this study.

The key design changes to this study involved first of all the length and specificity of the context scenarios. Increased specificity was aimed at ensuring that the given context provided a sensible, salient antecedent for the pronoun in each of the possible test conditions. This involved taking more careful account of the semantic requirements introduced by the use of *only* as modifying the matrix NP vs the pronoun, and (potentially) introducing additional discourse referents as a means of satisfying these requirements. As a result, the scenarios expanded in length: (72) is the redesigned version of the stimulus item in (65).

- (72) Two or three local business executives have decided to run for political office in San Francisco, due to the large number of regulatory measures currently under debate in city government. Each of them has been campaigning for support within the business and financial community, with varying degrees of success. They have also each faced pushback from businesspeople who are supporting the other candidates. Arthur, Jessica, and Frank work at a small start-up in the city.
- a. *Null*: Before deciding who to support, Arthur wanted to find out which executive his business partners had endorsed.
 - b. *Pro-focus*: Before deciding who to support, Arthur wanted to find out which executive only his business partners had endorsed.
 - c. *NP-focus*: Before deciding who to support, only Arthur wanted to find out which executive his business partners had endorsed.

Based on the results from both Hofmeister and Sag (2010) and Wasow and Clausen (2011) which suggest that increased specificity in the *wh*-phrase eases in processing of extraction, target sentences in all stimuli in this version of the study extracted a *wh*-phrase of the form *which X* instead of the bare *who* that had been present in earlier versions. This modification was aimed at controlling any pragmatic and/or processing variation introduced by variable specificity in the extracted element.

In addition, the phrasing of the question presented to a participant was standardized to the degree possible. Modal verbs (*who could the executive . . .*) were eliminated, and the question was tied as directly as possible to the content of the target sentence. Use of the adjective *own* was also eliminated from answer options, as it has a potential interaction with focus. (73) gives the question and answer options corresponding to (72).

- (73) **Who did Arthur want to identify?**
- a. *WCO*: An executive who had been endorsed by that executive’s business partners.
 - b. *Non-WCO*: An executive who had been endorsed by Arthur’s business partners.

The second major design change involved the inclusion of control conditions. The discussion in 5.2.7 raised the issue of world knowledge and other biases that might predispose participants towards a coreferenced or noncoreferenced interpretation of the target sentence.

This is difficult to control for since it also depends on participant-specific knowledge (to which we typically do not have access); however, it is possible to assess and record any inherent bias towards one interpretation or another, in the absence of the complications introduced by crossover. To do this, I included a control condition which matched the test conditions almost exactly; the difference between test and control conditions was that the target sentence was rephrased to a passive, which eliminated the crossover configuration without changing any of the conveyed meaning. Since the semantic content was unchanged, the potential antecedents and therefore the possible answers to the trial question were unaffected. In theory, an inherent bias towards one of the two answers in (73) would therefore be revealed by responses in the control condition (74).

- (74) Two or three local business executives have decided to run for political office in San Francisco, due to the large number of regulatory measures currently under debate in city government. Each of them has been campaigning for support within the business and financial community, with varying degrees of success. They have also each faced pushback from businesspeople who are supporting the other candidates.
Arthur, Jessica, and Frank work at a small start-up in the city.
- a. *Control*: Before deciding who to support, Arthur wanted to find out which executive had been endorsed by his business partners.

Finally, Study III included matched fillers in place of the unrelated fillers from Pilots I and II (see 67-68). The context scenarios for these fillers remained unchanged from the test and control scenarios. The target sentences contained embedded *wh*-questions with a potentially coreferent interpretation between a *wh*-phrase and a pronoun, but (as with the controls), these did not involve crossover. The filler associated with (72) is given in (75). Note that the noncoreferent interpretation necessarily differs from that of the test and control conditions, meaning that fillers are not directly comparable to other conditions. The answer possibilities for (75) are given in (76).

- (75) Two or three local business executives have decided to run for political office in San Francisco, due to the large number of regulatory measures currently under debate in city government. Each of them has been campaigning for support within the business and financial community, with varying degrees of success. They have also each faced pushback from businesspeople who are supporting the other candidates.
Arthur, Jessica, and Frank work at a small start-up in the city.
- a. *Filler*: Before deciding who to support, Arthur wanted to find out which executive's business partners had endorsed him.
- (76) **Who did Arthur want to identify?**
- a. *Coreferenced*: An executive whose partners endorsed that executive.
- b. *Noncoreferenced*: An executive whose partners endorsed Arthur.

The unrelated filler type was omitted in Study III.

Participants in Study III were asked to respond to only ten trials (instead of twelve), given the increased length of each trial. As before, after reading the context paragraph,

they were able to click on a *Show Question* button to reveal the associated multiple-choice question. There were ten extended scenarios in total developed for Study III; for a given participant, five of these were assigned at random to the test conditions, while the remaining five scenarios were assigned as either fillers or controls. This ensured that each participant saw a given context scenario exactly once. As before, test scenarios were randomly assigned to one of the null, NP-focus, or pronoun-focus conditions; non-test trials in Study III were randomly assigned as either fillers or controls. As before, participants were required to answer the question associated with a given scenario before proceeding to the next trial. The study can be viewed at web.stanford.edu/~pnadath/wco-nov15.html.

125 participants were recruited for Study III, via Mechanical Turk. All of them were financially compensated. Two of these reported being native speakers of a language other than English, and their data was excluded prior to analysis, leaving data from 123 participants in total.

4.3.2 Predictions

The predictions for Study III do not deviate significantly from those for Pilot II, due to the similarity of experimental design, particularly with respect to the answer options presented to participants. On the assumption that WCO is not ungrammatical, we expect a statistically nonzero percentage of respondents to report generating the coreferenced interpretation in all test conditions. By construction, each scenario should make both the coreferent and noncoreferent interpretations of the target sentence plausible independent of WCO considerations; however control data will allow us to determine whether any given scenario has a strong inherent bias towards one option or another.

Assuming no such biases, we expect a significant increase in the rate of WCO interpretation moving from the null to the pronoun-focus condition as a result of the target manipulation. Predictions for the NP-focus condition are also similar to those described for Pilot II. We expect that focus will privilege WCO readings in the pronoun-focus condition, but not in the NP-focus condition; however, we no longer expect the NP-focus conditions to involve an additional cognitive confound, as the stimuli in this experiment were developed to present a clear reason for the use of focus on the matrix subject.

One benefit of the Study III redesign is that it permits investigation of the proposals in Section 2 regarding the forces governing crossover, as well as into the effects of focus manipulations. Target sentences in control conditions all involve passivization of the (null) test target sentences; this means that the pronoun-containing subject is demoted to an oblique, which also reverses the (linear) order in which the anchor and pronoun appear. Thus, if the coreference reading is generated at significantly higher rates in the control as opposed to the null test condition, this will provide evidence that at least one of the principles of linear order and syntactic rank is in force with respect to the processing challenge associated with WCO.²⁰ A comparison of control and filler conditions may permit further refinement of

²⁰It is worth noting that this result could also be compatible with some version of the trace hypothesis, but we rule out the grammatical view if the main results of the study are as predicted.

this: compare the control and filler target sentences in the “business” scenario, reproduced from (74a) and (75a) above:

(74a) *Control*: Before deciding who to support, Arthur wanted to find out which executive had been endorsed by his business partners.

(75a) *Filler*: Before deciding who to support, Arthur wanted to find out which executive’s business partners had endorsed him.

Although the noncoreferent interpretations of these two sentences are no longer equivalent, the coreferent interpretations are. The filler construction involves converting the operator-containing noun phrase into a genitive (compare *Who_i did his_i mother greet?* to *Whose_i mother greeted him_i?*). At the same time, the pronoun no longer occurs in a possessive, but now represents the direct object of the embedded sentence in its entirety. Since DOBJ > GEN according to the syntactic hierarchy, this is a clear ordering relationship between the operator and pronoun with respect to syntactic rank. On the other hand, the linear ordering between pronoun and anchor (see 74a-75a) is unchanged. Thus, if we observe a statistical difference in the rate of coreferent interpretation rates – specifically, if coreference rates are higher in controls than fillers, this may be evidence that the governing principle of crossover is not crossing, per se, but rather syntactic rank.

4.3.3 Results

Composite results from the test conditions of Study III are given in Figure (8), alongside results from the control condition. The *y*-axis represents the percentage of respondents who generated the coreferenced interpretation (WCO for test conditions); control data is in grey, NP-focus in purple, null in blue, and pro-focus in green. Error bars represent 95% binomial confidence intervals. Corresponding numerical data is given in Table (8), where *N* represents the total number of responses collected in a particular condition.

Crucially, coreferenced interpretation is statistically nonzero in all conditions shown in Figure (8), including the null and NP-focus conditions. These two conditions show statistically equivalent WCO response rates (22.86% null; 22.78% NP-foc). Coreferenced interpretation rates are significantly up in the pronoun-focus condition (at 36.31%); there is no error bar overlap between the pro-focus condition and either of the other test conditions. Coreference interpretation rates are also significantly up in the control condition (44.83%). This represent a significant increase even over the coreference interpretation rate in the pro-focus condition, since the confidence intervals bars do not overlap at the midpoints. It is worth noting that the control rate of coreference overlaps 50% and is therefore, statistically speaking, at chance.

A by-scenario breakdown of the results is presented in Figure (9). Although this does show some variation in baseline coreference rates between scenarios (for instance, compare “business” to “chair”), the overall pattern of results between conditions remains consistent across the board.²¹

²¹There is one possible exception to this statement, the “orchestra” condition. It seems likely that the

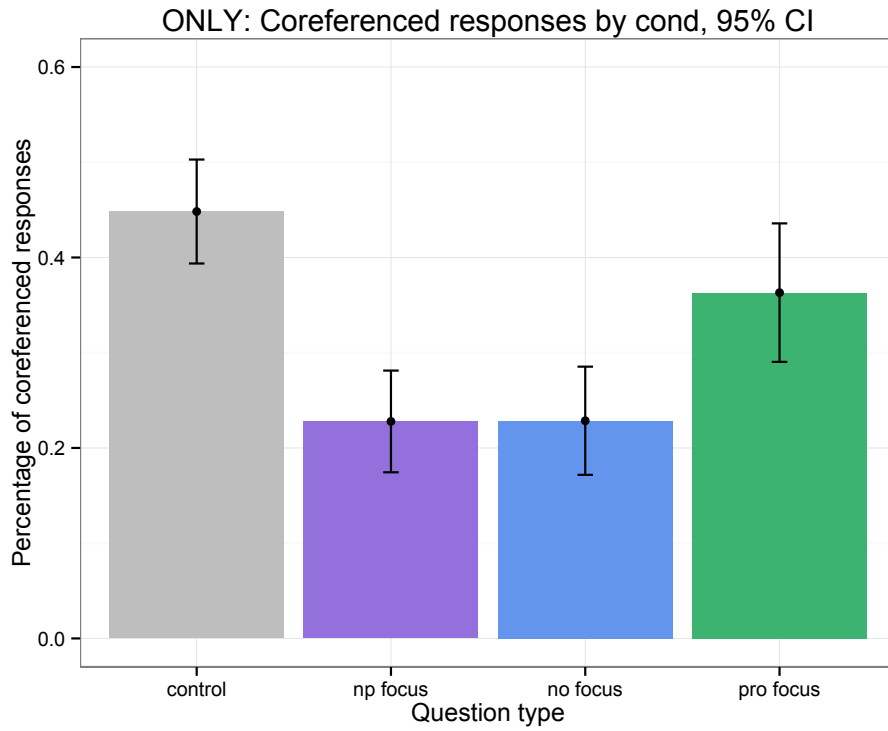


Figure 8: Composite test and control results for Study III

Figure 9: Test and control results for Study III, by scenario

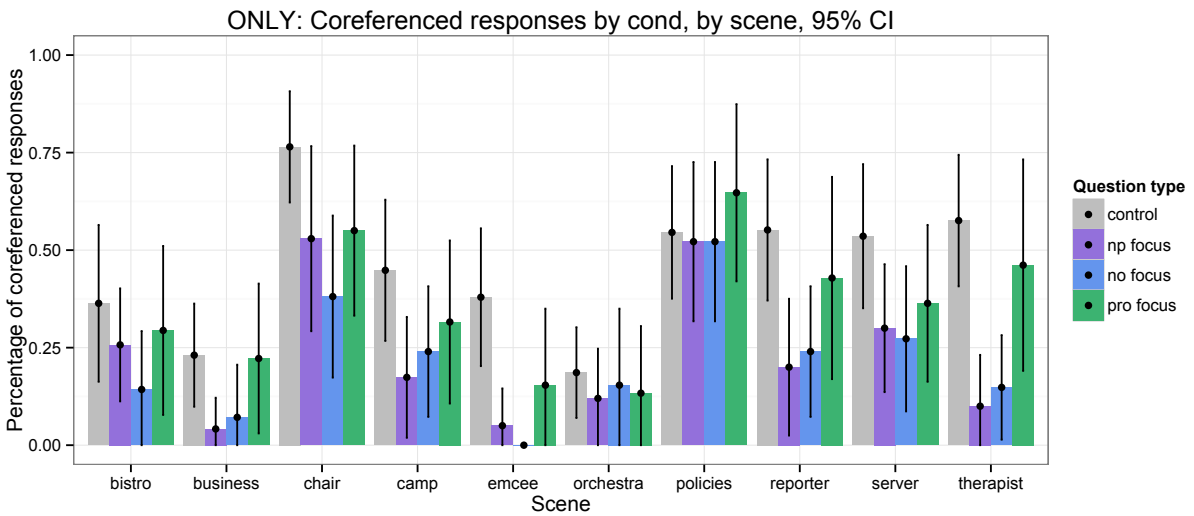
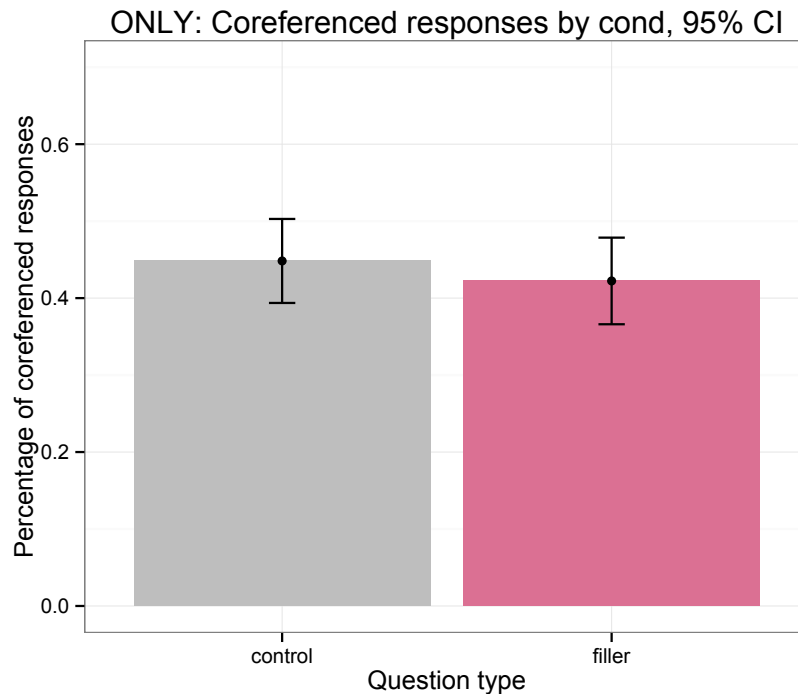


Figure (10) shows composite results from fillers (in pink) as compared to controls (in grey). The coreference rates in these two conditions turn out to be statistically equivalent (42.23 filler, 44.83 control). Detailed reports in Figure (11) shows that this equivalence is driven by variation between the individual conditions (compare, e.g. “bistro” to “chair”). Since the answer options for fillers and controls were not identical (see the discussion in 5.3.1), this variation is most likely due to variation in the contextual plausibility of one anaphoric resolution vs. another.

Figure 10: Composite filler and control results for Study III



4.3.4 Discussion

Overall, the results from Study III support predictions made on the hypothesis that WCO is not ungrammatical, but instead involves processing challenges. Test stimuli were constructed so that both the coreferenced and non-coreferenced interpretation of the pronoun had plausible antecedents on the pragmatic/discourse level. Thus, if WCO truly constituted a grammatical violation, we would expect responses to default to the only answer that was both grammatically and pragmatically viable – that is, the noncoreferenced interpretation. In particular, allowing for some level of participant inattention or error, we would expect error bars in the null condition to overlap a 0.00% coreference response rate; the fact that

subject matter of this scenario may have been unfamiliar to respondents which might account for the unusual pattern.

Figure 11: Filler and control results for Study III, by scenario

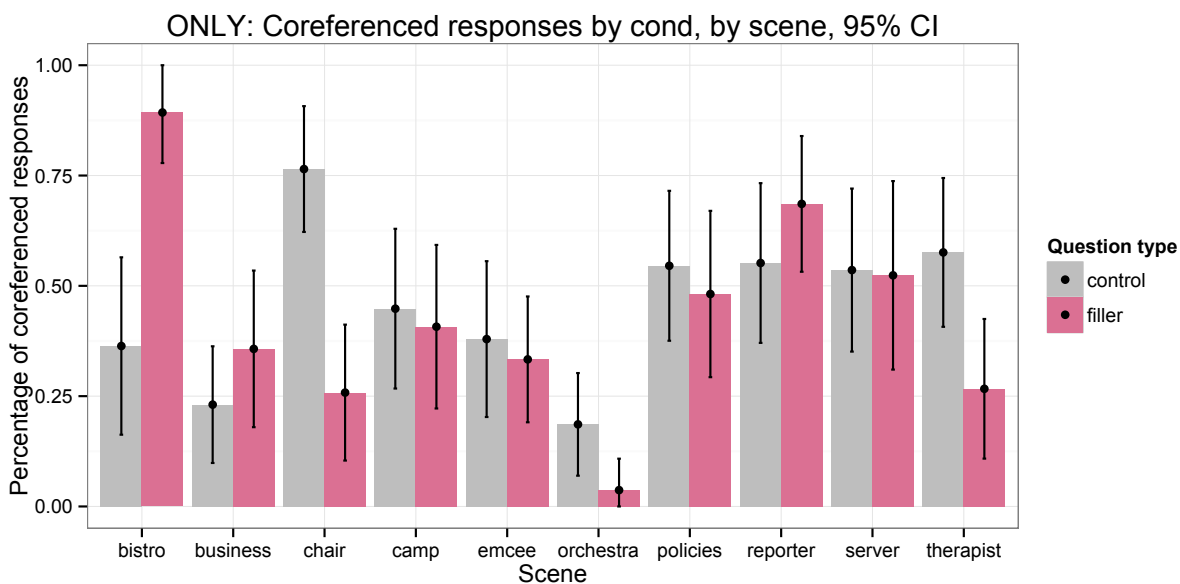


Table 8: Composite results for Study III, by condition

<i>Question type</i>	<i>N</i>	<i>% CR responses</i>
NP-focus	237	22.78 ± 5.34
null	210	22.86 ± 5.68
pro-focus	168	36.31 ± 7.27
control	319	44.83 ± 5.46
filler	296	42.23 ± 5.63

Table 9: Results for Study III, by scenario

<i>Question type</i>	<i>N</i>	<i>% CR</i>	<i>N</i>	<i>% CR</i>	<i>N</i>	<i>% CR</i>
		<i>bistro</i>		<i>business</i>		<i>chair</i>
NP-focus	35	25.71 ± 14.48	24	4.17 ± 7.99	17	52.94 ± 23.73
null	21	14.29 ± 14.96	14	7.14 ± 13.49	21	38.10 ± 20.78
pro-focus	17	29.41 ± 21.66	18	22.22 ± 19.20	20	55.00 ± 21.80
control	22	36.36 ± 20.10	39	23.08 ± 13.23	34	76.47 ± 14.26
filler	28	89.29 ± 11.46	28	35.71 ± 17.74	31	25.81 ± 15.41
		<i>camp</i>		<i>emcee</i>		<i>orchestra</i>
NP-focus	23	17.39 ± 15.49	20	5.00 ± 9.55	25	12.00 ± 12.74
null	25	24.00 ± 16.74	19	0.00 ± 0.00	13	15.38 ± 19.62
pro-focus	19	31.58 ± 20.90	13	15.38 ± 19.62	15	13.33 ± 17.21
control	29	44.83 ± 18.10	29	37.93 ± 17.66	43	18.60 ± 11.63
filler	27	40.74 ± 20.53	42	33.33 ± 14.25	27	3.70 ± 7.13
		<i>policies</i>		<i>reporter</i>		<i>server</i>
NP-focus	23	52.17 ± 20.41	20	20.00 ± 17.53	30	30.00 ± 16.40
null	23	52.17 ± 20.41	25	24.00 ± 16.74	22	27.27 ± 18.61
pro-focus	17	64.71 ± 22.72	14	42.86 ± 25.93	22	36.36 ± 20.10
control	33	54.55 ± 19.66	29	55.17 ± 18.10	28	53.57 ± 18.47
filler	27	48.15 ± 19.84	35	68.57 ± 15.38	21	52.38 ± 21.36
		<i>therapist</i>				
NP-focus	20	10.00 ± 13.15				
null	27	14.81 ± 13.40				
pro-focus	13	46.15 ± 27.10				
control	33	57.58 ± 16.87				
filler	30	26.67 ± 15.83				

this does not occur in any of the test conditions strongly supports the hypothesis advocated for in this paper.

There is one potential caveat to this interpretation of the results, but this was investigated via the inclusion of the control conditions in Study III. If the plausibility of the coreferenced interpretation were much higher than the plausibility of the noncoreferenced interpretation (pragmatically speaking), it is at least possible that participants would have sometimes picked an “ungrammatical” answer to the test questions in accordance with some aspect of the cooperative principle (Grice 1957, Levinson 2000).²² This possibility is ruled out, however, by the fact that responses in the control condition show that coreferenced interpretations were generated only at chance: this suggests that, on the whole, noncoreferenced interpretations were at least as plausible as coreferenced ones. In the detail analysis, we do find that the “chair” scenario is a potential exception to this generalization – but even in this case (and taking into account the small per-scenario sample size), we find that the relative rate of coreferenced interpretations in test conditions compares to the scenarios where control coreference rates are at chance. Thus, the control data from Study III strongly suggests that WCO “violations” are not simply being rescued from rejection due to a (potential) pragmatic bias.

Moving to a comparison of the test conditions, Study III provides data in support of Postal’s data (12c): that WCO sentences which use *only* to modify the pronoun-containing constituent are judged to be more acceptable than otherwise equivalent sentences without the focus adverbial.

4.4 Experiment IV: emphasis or intonational focus

4.4.1 Design

Based on the positive results of Study III, I conducted a final study aimed at investigating whether the mitigating effect of focus manipulations is limited to focus adverbials such as *only*, or whether it is associated with focus as a general category. One well-known means of achieving focus structure is through prosody or intonation – specifically, an emphasized element or constituent in English is often perceived as focused. An obvious follow-up study to the investigation of *only* described in section 5.3, then, would investigate whether emphasis/intonation-based focus manipulations have the same effect on the perceived acceptability of WCO sentences.

The most direct method of investigating intonational effects would, of course, be through speech. In the interests of scalability (that is, collecting a large number of responses) and maintaining maximal comparability to Study III, however, I administered an intonation-base study in a written format, using capitalization to indicate intonational emphasis. Some motivation for this approach is taken from Knecht (2015), who investigates focus and extraction in written studies by this means.

²²This caveat also has to do with the experimental methodology – since test questions were phrased as comprehension questions, instead of grammaticality assessments, hearers might well have been predisposed to “make sense” of what was communicated independently of its grammatical status.

The only change in experimental design moving from Study III to Study IV, then, involved the target sentences for items in the NP-focus and pro-focus conditions. These previously were the test conditions that included the focus adverbial *emph*; in Study IV the target sentences corresponding to (72b) and (72c) were presented as follows:

- (77) a. *Pro-focus*: Before deciding who to support, Arthur wanted to find out which executive HIS business partners had endorsed.
- b. *NP-focus*: Before deciding who to support, ARTHUR wanted to find out which executive his business partners had endorsed.

The ten scenarios developed for Study III were used in Study IV as well, with the NP-focus and pro-focus conditions adjusted to reflect intonational emphasis as above. Fillers and controls remained unchanged, as did the null test condition. As before, participants saw each of the ten scenarios exactly once; five in randomly-assigned test conditions, and five randomly assigned as either fillers or controls. The experiment was conducted, as before, via Mechanical Turk. One minor change was made to the pre-experimental instructions: the information that capital letters might be used to indicate emphasis was made explicit. An example item in the instruction section also demonstrated this. The study, along with instructions, can be viewed at web.stanford.edu/~pnadath/experiments/wco-caps.html.

Study IV collected data from 125 participants, all of whom were financially compensated. One of these reported being a native speaker of a language other than English, and this participant's data was excluded prior to analysis.

4.4.2 Predictions

Study IV involves two crucial assumptions. The first of these is that emphasis/capitalization indicates focus on a particular element, and the second is that the focus thereby indicated involves the same sort of mechanisms (i.e. invoking alternatives, etc) as modification by focus adverbials. As noted, Knecht (2015) suggests the validity of the first assumption; focus literature including Rooth (1992) tends to suggest the validity of the second.

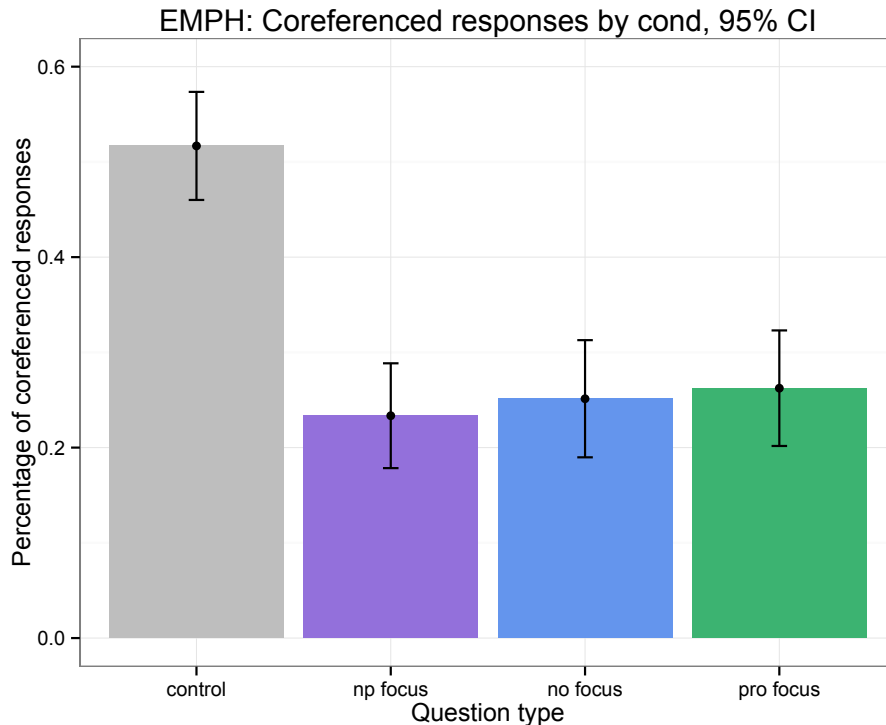
Given these assumptions, the predictions for Study IV are identical to those outlined for Study III. All test conditions should show a statistically nonzero rate of WCO interpretation; this rate should increase significantly in the pro-focus condition. Based on the results of Study III, we expect WCO rates in the null and NP-focus conditions to be comparable. Finally, we expect that controls will compare with test conditions in the same way as Study III shows; control coreference rates will be significantly higher than both pro-focus and null conditions, and we expect that they will be comparable to coreference rates in the filler condition (at least in the aggregate).

4.4.3 Results

Composite results from Study IV test conditions are given in Figure (12), alongside control results. As before, the y-axis represents the percentage of respondents who reported generating a coreferenced interpretation, with control data in grey, NP-focus in purple, null in

blue, and pronoun-focus in green. Error bars represents 95% binomial confidence intervals. Corresponding numerical data is given in Table (10), where N again represents the total number of responses collected for a given item.

Figure 12: Composite test and control results for Study IV

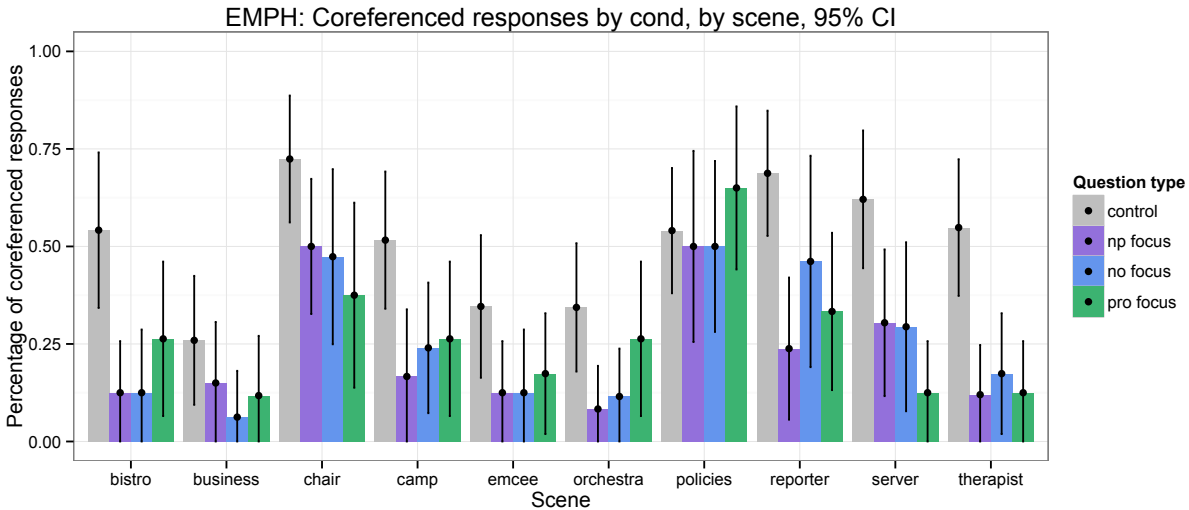


Coreferenced interpretation is statistically nonzero in all test and control conditions, with control coreference rates at chance, as in Study III (51.68%). Control coreference rates are significantly higher than in all test conditions; however, the results of the emphasis study deviate from Study III in that there is no statistical difference between WCO rates in any of the three test conditions. Crucially, where Study III coreference rates in the NP focus and null conditions were around 23%, and the pro-focus condition was around 36%, Study IV shows coreference rates in all three conditions at around 25% (23.35 NP; 25.15 null; 26.24 pro). Specifically, then, pronoun-focus coreference rates are down as compared to the pronoun-focus condition in Study III, where focus effects were achieved via modification by *only* instead of capitalization to indicate emphasis.

The by-scenario breakdown of the results is given in Figure (13). The pattern of individual scenario results more closely resembles the comparison between control and filler conditions in Study III than the comparison between null/NP-focus and pro-focus conditions; observe that in almost all cases the control coreference rates are markedly higher than the coreference rates in any test conditions, but there is significant variation from scenario to scenario between the coreference rates achieved in the null/NP-focus conditions (which are usually

close together), and the pro-focus condition (compare, e.g. “bistro” to “server”). This suggests that the aggregate equivalence is driven by scenario-based variation; this is perhaps a puzzling result when compared to Study III, and is discussed in the following section.

Figure 13: Test and control results for Study IV, by scenario



Figures (14)-(15) show the results from fillers (in pink) alongside control results (in gray). As in Study III, the composite results show that coreference rates for fillers and controls are statistically equivalent; the detail breakdown shows that this is driven, as before, by scenario-to-scenario variation (compare e.g. “emcee” to “therapist”).

Table 10: Composite results for Study IV, by condition

<i>Question type</i>	<i>N</i>	<i>% CR responses</i>
NP-focus	227	23.35 ± 5.51
null	191	25.13 ± 6.15
pro-focus	202	26.24 ± 6.07
control	298	51.68 ± 5.68
filler	322	55.90 ± 5.42

4.4.4 Discussion

The results from Study IV again support the basic premise of this investigation: that WCO readings are not ungrammatical and are available in all cases. However, these Study IV results deviate from those of Study III in that they do not provide clear evidence that focus

Figure 14: Composite filler and control results for Study IV

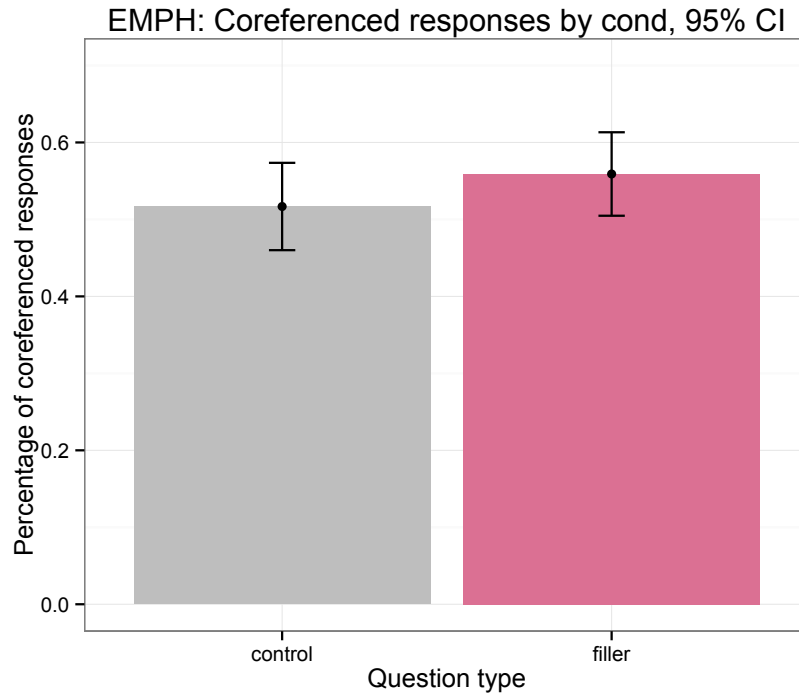


Figure 15: Filler and control results for Study IV, by scenario

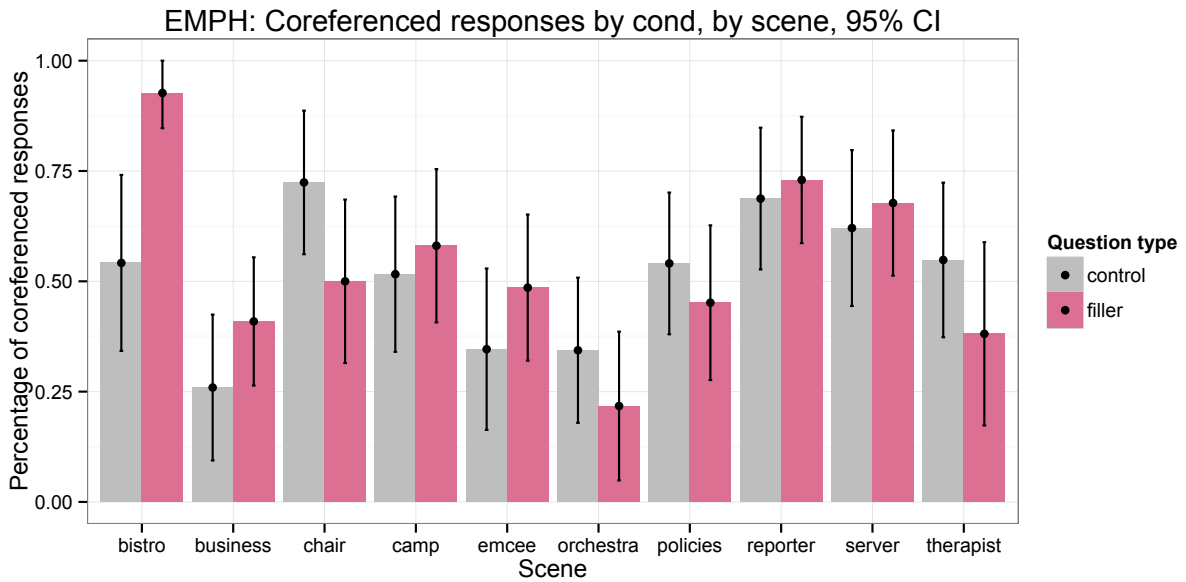


Table 11: Results for Study IV, by scenario

<i>Question type</i>	<i>N</i>	<i>% CR</i>	<i>N</i>	<i>% CR</i>	<i>N</i>	<i>% CR</i>
		<i>bistro</i>		<i>business</i>		<i>chair</i>
NP-focus	24	12.50 ± 13.23	20	15.00 ± 15.65	32	50.00 ± 17.32
null	16	12.50 ± 16.20	16	6.25 ± 11.86	19	47.37 ± 22.45
pro-focus	19	26.31 ± 19.79	17	11.76 ± 15.32	16	37.50 ± 23.72
control	24	54.17 ± 19.94	27	25.93 ± 16.53	29	72.41 ± 16.26
filler	38	92.68 ± 7.97	44	40.91 ± 14.53	28	50.00 ± 18.52
		<i>camp</i>		<i>emcee</i>		<i>orchestra</i>
NP-focus	18	16.67 ± 17.21	24	12.50 ± 13.23	24	8.33 ± 11.06
null	25	24.00 ± 16.74	16	12.50 ± 16.21	26	11.54 ± 12.28
pro-focus	19	26.32 ± 19.80	23	17.39 ± 15.49	19	26.32 ± 19.80
control	31	51.61 ± 17.59	26	34.62 ± 18.29	32	34.38 ± 16.46
filler	31	58.06 ± 17.37	35	48.57 ± 16.56	23	21.74 ± 16.86
		<i>policies</i>		<i>reporter</i>		<i>server</i>
NP-focus	16	50.00 ± 24.50	21	23.81 ± 18.22	23	30.43 ± 18.80
null	20	50.00 ± 21.91	13	46.15 ± 27.10	17	29.41 ± 21.66
pro-focus	20	65.00 ± 20.90	21	33.33 ± 20.16	24	12.50 ± 13.23
control	37	54.05 ± 16.05	32	68.75 ± 16.06	29	62.07 ± 17.66
filler	31	45.16 ± 17.52	37	72.97 ± 14.31	31	67.74 ± 16.45
		<i>therapist</i>				
NP-focus	25	12.00 ± 12.74				
null	23	17.39 ± 15.49				
pro-focus	24	12.50 ± 13.23				
control	31	54.84 ± 17.52				
filler	21	38.10 ± 20.78				

in general improves or “boosts” crossover readings. In particular, while Study III showed that WCO readings were more readily available in pronoun-focus conditions, Study IV shows (overall) no significant difference across the NP-focus, pro-focus and null conditions. Moreover, scenario-based variation was significantly higher than in the Study III cases.

These results seem puzzling on the hypothesis as outlined in section 3.2. In particular, I hypothesized that it was specifically the presence of two focus-sensitive elements that produced the effect, and supported this with preliminary data from a comparison of WCO sentences with focus adverbials other than *even* and *only*, as well as a comparison of clefted vs. topicalized sentences. In that case, intonational focus should produce the same effect as focusing the possessive pronoun with *even* or *only*, and we should expect the same boost to WCO readings.

One possible explanation for the deviation between Studies III and IV may be that the stable semantic content of focus adverbials like *even* and *only* facilitates the identification of the two focus slots. Intonational focus, on the other hand, while it can produce infelicity/inappropriateness effects, does not necessarily contribute any stable semantic content, which means that the interlocutor must rely on a much wider set of pragmatic/contextual features to justify the use of focus. This would account for the scenario-based variation level evident in the emphasis study that did not appear to be present in the focus adverbial study. Relatedly, it may also be the case that intonational focus is preferentially interpreted as *contrastive* (Rooth 1985, 1992), which might in fact counteract any work that generic focus marking would do to make identification of *wh*-element and pronoun more salient than in the null conditions.

5 Conclusions and questions

This investigation of weak crossover has raised a number of issues for traditional grammatical and/or trace-based treatments of the phenomena. Since Wasow’s classification of WCO as distinct from strong crossover, there have been certain data in the literature supporting (at least at the introspective level) a certain variability in acceptability judgements for “weakly crossed” sentences. This variability has not been given much airtime, other than Wasow’s original suggestion that the coreference problem in WCO is essentially equatable to one of cataphora.

In this paper, I have pursued an explanation of this variability from a processing account of WCO acceptability judgements. I have argued that a processing view is supported both by experimental evidence regarding extractions in general (cf Hofmeister and Sag 2010), as well as by the observation (from Postal and others) that appending a focus adverbial such as *even* or *only* to the coreferential pronoun in a WCO sentence renders them more or less acceptable under the intended indexation. In particular, I have suggested that the “problem” with WCO sentences is not one of grammatical violation, but rather one of the combined processing load of extraction and coreference. In configurations where the extraction is not resolved at the time that the pronoun is encountered, the cognitive “path of least resistance” involves assigning the pronoun a (sentence)-new referent. Focus particles

change this by privileging a connection between the *wh*-alternatives and the alternatives invoked relative to the pronoun – I have suggested that the path of least resistance in this case involves resolving both the pronoun reference and the justification of dual focus with one computation – linking the pronominal variable to the *wh*-operator. I have presented this hypothesis only in a very rough form – an immediate avenue for future investigation would be to formalize this in terms of (a) standard processing theories, (b) a more thorough investigation of the relationship between focus and interrogative forms, and (c) a more developed theory of alternative-generation with respect to pronominals (Mayr 2010).

Although the theory of focus improvements will bear significant further revision and investigation, this paper has also provided some support for not only this theory, but an overall processing view of WCO along the lines outlined here, on the basis of an experimental investigation of focus effects. This has shown not only that WCO readings are, in general, available at a non-zero rate, but in particular has provided the first empirical evidence for Postal’s observations regarding *even* and *only*. With respect to the hypothesis presented here, the data from Experiment III support a focus boost to coreference for adverbials, but the data from Experiment IV pose a new challenge for understanding the effect of focus on WCO. In particular, a replication of the *only* study (Experiment III) using emphasis to stand in for intonational focus was unable to replicate the results demonstrating focus improvements (although the baseline availability of WCO readings was supported). This suggests, moving forward, that a more nuanced understanding of the effects of focus will be important in articulating a clearer theory of the effect that focus marking has on crossover/coreference, and pragmatic or deictic resolution in general. A particularly promising avenue for investigation seems to be one in which the connection between something like Rooth’s focus semantic level and the ordinary semantic level is more carefully analyzed – in particular, it seems likely that focus adverbials such as *even* and *only*, which have CI and entailment-level effects in addition to their pragmatic ones, perhaps preclude an interpretation of focus as contrastive. Intonational focus, on the other hand, can often be used for contrast. While we would like a theory on which various notions of focus can be assimilated to something like an alternative semantics, this suggests that the way in which alternatives are considered may vary significantly based on the presence of asserted/entailed effects from focus – and, in particular, that the difference between contrastive focus and other uses of focus marking are in need of more thorough investigation.

References

- Ades, Anthony and Steedman, Mark. 1982. On the order of words. *Linguistics and Philosophy* 4, 517–558.
- Anderson, John and Reder, Lynne. 1979. An elaborative processing explanation of depth of processing. In Laird Cermak and Fergus Craik (eds.), *Levels of processing in human memory*, pages 385–404, Lawrence Erlbaum.
- Bach, Emmon. 1979. Control in Montague grammar. *Linguistic Inquiry* 10, 515–531.
- Berman, Judith. 2000. *Topics in the clausal syntax of German*. Ph.D.thesis, University of Stuttgart.
- Bradshaw, Gary and Anderson, John. 1982. Elaborative encoding as an explanation of levels of processing. *Journal of Verbal Learning and Verbal Behavior* 21, 165–174.
- Bresnan, Joan. 1971. Contraction and the transformational cycle in English, Indiana University Linguistics Club.
- Bresnan, Joan. 1994. Linear order vs syntactic rank: evidence from weak crossover. In Katie Beals, Jeanette Denton, Bob Knippen, Lynette Melnar, Hisami Suzuki and Erika Zeinfeld (eds.), *Papers from the Thirtieth Regional Meeting of the Chicago Linguistic Society*, University of Chicago.
- Bresnan, Joan. 1995. Linear order, syntactic rank, and empty categories: on weak crossover. In Dalrymple et al. (1995), pages 241–274.
- Bresnan, Joan, Asudeh, Ash, Toivonen, Ida and Wechsler, Stephen. 2015. *Lexical-Functional Syntax*. Oxford: Wiley-Blackwell, second edition.
- Butt, Miriam. 1993. *The structure of complex predicates in Urdu*. Ph.D.thesis, Stanford University.
- Carnie, Andrew. 2007. *Syntax: A Generative Introduction*. Oxford: Blackwell.
- Chaves, R. 2010. On the grammar of extraction and coordination. *Natural Language and Linguistic Theory* 28.
- Chierchia, Gennaro. 1992. Functional *wh* and weak crossover. In *Proceedings of the 10th West Coast Conference on Formal Linguistics*, volume 10, CSLI.
- Chomsky, Noam. 1957. *Syntactic structures*. Berlin: Walter de Gruyter.
- Chomsky, Noam. 1976. Conditions on rules of grammar. *Linguistic Analysis* 2, 303–351.
- Chomsky, Noam. 1981. *Lectures on Government and Binding*. Mouton de Gruyter.

- Crain, Stephen and Fodor, Janet. 1985. How can grammars help parsers? In David Dowty, Lauri Karttunen and Arnold Zwicky (eds.), *Natural Language Parsing: Psychological, Computational, and Theoretical Perspectives*, pages 94–128, Cambridge: Cambridge University Press.
- Culicover, Peter and Wilkins, Wendy. 1984. *Locality in linguistic theory*. New York: Academic Press.
- Dalrymple, Mary, Kaplan, Ronald and King, Tracy Holloway. 2001. Weak crossover and the absence of traces. In Miriam Butt and Tracy Holloway King (eds.), *Proceedings of the LFG01 Conference*, pages 66–82, Stanford: CSLI.
- Dalrymple, Mary, Kaplan, Ronald, Maxwell, John and Zaenen, Annie (eds.). 1995. *Formal Issues in Lexical-Functional Grammar*. Stanford: CSLI.
- Dalrymple, Mary and King, Tracy Holloway. 2013. Nested and crossing dependencies and the existence of traces. In Tracy Holloway King and Valeria de Paiva (eds.), *From Quirky Case to Representing Space: Papers in Honor of Annie Zaenen*, Stanford: CSLI.
- Deane, Paul. 1991. Limits to attention: a cognitive theory of island phenomena. *Cognitive Linguistics* 2, 1–63.
- Dowty, David. 1985. On recent analyses of the semantics of control. *Linguistics and Philosophy* 8, 291–331.
- Dryer, Matthew. 1980. The positional tendencies of sentential noun phrases in universal grammar. *The Canadian Journal of Linguistics* 25, 123–196.
- Dryer, Matthew. 1986. Primary objects, secondary objects, and antitativity. *Language* 62, 808–845.
- Falk, Yehuda. 2007. Do we wanna (or hafta) have empty categories? In Miriam Butt and Tracy Holloway King (eds.), *Proceedings of the LFG07 Conference*, Stanford: CSLI.
- Fanselow, Gisbert, Kliegl, Reinhold and Schlesewsky, Matthias. 2005. Syntactic variation in German wh-questions. *Linguistic Variation Yearbook* 5, 37–63.
- Farmer, Ann, Hale, Ken and Tsujimura, Natsuko. 1986. A note on weak crossover in Japanese. *Natural Language and Linguistic Theory* 4, 33–42.
- Fauconnier, Giles. 1975a. Polarity and the scale principle. In *Chicago Linguistic Society*, volume 11, pages 188–199.
- Fauconnier, Giles. 1975b. Pragmatic scales and logical structure. *Linguistic Inquiry* 6, 353–375.
- Georgopoulos, Carol. 1991a. Canonical government and the specifier parameter: an ECP account of weak crossover. *Natural Language and Linguistic Theory* .

- Georgopoulos, Carol. 1991b. *Syntactic variables: resumptive pronouns and A' binding in Palauan*.. Dordrecht: Kluwer Academic.
- Gibson, Edward. 1998. Linguistic complexity: locality of syntactic dependencies. *Cognition* 68, 1–76.
- Grice, Paul. 1957. Meaning. *The Philosophical Review* 66, 377–388.
- Groenendijk, Jeroen and Stokhof, Martin. 1984. *Studies on the semantics of questions and the pragmatics of answers*. Ph. D.thesis, University of Amsterdam.
- Hamblin, Charles. 1973. Questions in Montague English. *Foundations of Language* 10, 41–53.
- Hawkins, John. 1999. Processing complexity and filler-gap dependencies across grammars. *Language* 75, 244–285.
- Hirschberg, J. 1985. *A theory of scalar implicature*. Ph. D.thesis, University of Pennsylvania.
- Hofmeister, Philip. 2007. *Representational complexity and memory retrieval in language comprehension*. Ph. D.thesis, Stanford University.
- Hofmeister, Philip and Sag, Ivan. 2010. Cognitive constraints and island effects. *Language* 86, 366–415.
- Horn, Laurence. 1969. A presuppositional analysis of *only* and *even*. In *Chicago Linguistic Society*, volume 5, pages 98–107.
- Horn, Laurence. 1972. On the Semantic Properties of Logical Operators in English. Mimeo, Indiana University Linguistics Club.
- Jacobs, Joachim. 1983. *Fokus und Skalen. Zur Syntax und Semantik der Gradpartikeln im Deutschen*.. Tübingen: Niemeyer.
- Jacobs, Joachim. 1988. Fokus-Hintergrund-Gliederung und Grammatik. In Hans Altmann (ed.), *Intonationsforschungen*, Niemeyer.
- Just, Marcel and Carpenter, Patricia. 1992. A capacity theory of comprehension: individual differences in working memory. *Psychological Review* 99, 122–149.
- Just, Marcel, Carpenter, Patricia and Woolley, J.D. 1982. Paradigms and processes in reading comprehension. *Journal of Experimental Psychology: General* 111, 228–238.
- Kaplan, Ronald. 1974. *Transient processing load in relative clauses*. Ph. D.thesis, Harvard University, Cambridge, MA.
- Kaplan, Ronald and Bresnan, Joan. 1982. Lexical-Functional Grammar: A formal system for grammatical representation. In Dalrymple et al. (1995), pages 29–130.

- Kaplan, Ronald and Zaenen, Annie. 1989. Long-distance dependencies, constituent structure, and functional uncertainty. In Dalrymple et al. (1995), pages 137–165.
- Karlsson, Fred. 2007. Constraints on multiple center-embedding of clauses. *Journal of Linguistics* 43, 365–392.
- Karttunen, Lauri. 1977. Syntax and semantics of questions. *Linguistic and Philosophy* 1, 3–44.
- Karttunen, Lauri and Peters, Stanley. 1979. Conventional implicature. In Oh and Dinnen (eds.), *Syntax and Semantics*, pages 1–56, New York: Academic Press.
- Kay, Paul. 1990. Even. *Linguistics and Philosophy* 13, 59–111.
- Keenan, Edward and Comrie, Bernard. 1977. Noun phrase accessibility and universal grammar. *Linguistic Inquiry* 8, 63–99.
- Kluender, Robert. 1992. Deriving island constraints from principles of predication. In Helen Goodluck and Michael Rochemont (eds.), *Island constraints: theory, acquisition, and processing*, pages 223–258, Dordrecht: Kluwer.
- Kluender, Robert. 1998. On the distinction between strong and weak islands: a processing perspective. In Peter Culicover and Louise McNally (eds.), *Syntax and Semantics 29: The Limits of Syntax*, pages 241–279, San Diego: Academic Press.
- Kluender, Robert. 2005. Are subject islands subject to a processing account? In Vineeta Chand, Ann Kelleher, Angelo Rodríguez and Benjamin Schmeiser (eds.), *Proceedings of the 23rd West Coast Conference on Formal Linguistics*, pages 475–499, Somerville, MA: Cascadilla Press.
- Knecht, Marion. 2015. English and German focus particles and extraction. Handout, Tübingen.
- König, Ekkehard. 1991. *The meaning of focus particles*. New York: Routledge.
- Koopman, Hilda and Sportiche, Dominique. 1983. Variables and the bijection principle. *The Linguistic Review* 2, 139–160.
- Kratzer, Angelika. 1991. The representation of focus. In Arnim von Stechow and Dieter Wunderlich (eds.), *Handbook of semantics*, pages 825–834, de Gruyter.
- Kroch, Anthony. 1998. Amount quantification, referentiality, and long WH-movement. In *Penn Working Papers in Linguistics*, volume 5.2, Philadelphia: University of Pennsylvania.
- Kuno, Susumo. 1974. The position of relative clauses and conjunctions. *Linguistic Inquiry* 5, 117–136.

- Lasnik, Howard and Stowell, Tim. 1991. Weakest crossover. *Linguistic Inquiry* 22, 687–720.
- Lauer, Sven and Condoravdi, Cleo. 2012. The basic dynamic effect of interrogative utterances. Slides from Texas Linguistics Society 13.
- Levinson, Stephen. 2000. *Presumptive meanings: the theory of generalized conversational implicature*. Cambridge MA: MIT Press.
- Lightfoot, David. 1976. Trace theory and twice-moved NPs. *Linguistic Inquiry* 7, 559–582.
- Löbner, Sebastian. 1989. *Schon - erst - noch*. An integrated analysis. *Linguistics and Philosophy* 12, 167–212.
- Mahajan, Anoop. 1990. *The A/A-bar distinction and movement theory*. Ph. D.thesis, Massachusetts Institute of Technology.
- Maling, Joan and Zaenen, Annie. 1982. A phrase structure account of Scandinavian extraction phenomena. In Pauline Jacobson and Geoffrey Pullum (eds.), *The Nature of Syntactic Representation*, pages 229–282, Dordrecht: Reidel.
- Mayr, Clemens. 2010. Contrastive salient alternatives: focus on bound pronouns. In *Proceedings of SALT*, volume 20, pages 1–15.
- McDaniel, Mark, Dunay, Paul, Lyman, Brian and Kerwin, Mary. 1989. Effects of elaboration and relational distinctiveness on sentence memory. *The American Journal of Psychology* 101, 357–369.
- Miller, George and Chomsky, Noam. 1963. Finitary models of language users. In R. Duncan Luce, Robert Bush and Eugene Galanter (eds.), *Handbook of Mathematical Psychology*, volume 2, pages 419–492, New York: Wiley.
- Mohanan, KP. 1983. Functional and anaphoric control. *Linguistic Inquiry* 14, 641–674.
- Mohanan, Tara. 1990. *Arguments in Hindi*. Ph. D.thesis, Stanford University.
- Montague, Richard. 1970a. English as a Formal Language. In Bruno Visentini (ed.), *Linguaggi nella società e nella tecnica*, pages 189–223, Mailand.
- Montague, Richard. 1970b. Universal grammar. *Theoria* 36, 373–398.
- Montague, Richard. 1973. The proper treatment of quantification in ordinary English. In Jaakko Hintikka, Julius Moravcsik and Patrick Suppes (eds.), *Approaches to Natural Language*, pages 221–242, Kluwer.
- Nadathur, Prerna. 2013. Weak crossover and the direct association hypothesis. In Miriam Butt and Tracy Holloway King (eds.), *Proceedings of the LFG13 Conference*, pages 461–481, Stanford: CSLI.

- Pesetsky, David. 1987. Wh-in-situ: movement and unselective binding. In Eric Reuland and Alice ter Meulen (eds.), *The Representation of (In)definiteness*, pages 98–129, Cambridge, MA: MIT Press.
- Pickering, Martin. 1993. Direct association and sentence processing: a reply to Gorrell and to Gibson and Hickok. *Language and Cognitive Processes* 8, 163–196.
- Pickering, Martin and Barry, Guy. 1991. Sentence processing without empty categories. *Language and Cognitive Processes* 6, 229–259.
- Postal, Paul. 1971. *Cross-over Phenomena*. New York: Holt, Rinehart and Winston.
- Postal, Paul. 1993. Remarks on weak crossover effects. *Linguistic Inquiry* 24, 539–556.
- Potts, Christopher. 2005. *The logic of conventional implicatures*. Oxford: Oxford University Press.
- Radford, Andrew. 1997. *Syntax: A Minimalist Introduction*. Cambridge: Cambridge University Press.
- Reinhart, Tanya. 1976. *The syntactic domain of anaphora*. Ph.D.thesis, Massachusetts Institute of Technology.
- Reinhart, Tanya. 1983. Coreference and bound anaphora: a restatement of the anaphora questions. *Linguistics and Philosophy* 6, 47–88.
- Rooth, Mats. 1985. *Association with focus*. Ph.D.thesis, University of Massachusetts-Amherst.
- Rooth, Mats. 1992. A theory of focus interpretation. *Natural Language Semantics* 1, 75–116.
- Ross, John Robert. 1967. *Constraints on variables in syntax*. Ph.D.thesis, Massachusetts Institute of Technology.
- Safir, Ken. 1984. Multiple variable binding. *Linguistic Inquiry* 15, 603–638.
- Safir, Ken. 1996. Derivation, representation, and resumption: the domain of weak crossover. *Linguistic Inquiry* 27, 313–339.
- Sag, Ivan. 1998. Without a trace, stanford University.
- Sag, Ivan and Fodor, Janet. 1992. Extraction without traces. In *Proceedings of the West Coast Conference on Formal Linguistics*.
- Selkirk, Elisabeth. 1984. *Phonology and Syntax: The Relation between Sound and Structure*. Cambridge, MA: MIT Press.
- Sportiche, Dominique. 1985. Remarks on crossover. *Linguistic Inquiry* 16, 460–469.

- von Stechow, Arnim. 1989. Focusing and backgrounding operators. In *Technical Report*, Fachgruppe Sprachwissenschaft, Universität Konstanz.
- Stowe, Laurie. 1986. Parsing WH-constructions: evidence for on-line gap location. *Language and Cognitive Processes* 1, 227–245.
- Swinney, David, Ford, M., Frauenfelder, Ulrich and Bresnan, Joan. 1988. On the temporal course of gap-filling and antecedent assignment during sentence comprehension. In Barbara Grosz, Ronald Kaplan, Marlys Macken and Ivan Sag (eds.), *Language Structure and Processing*, Stanford: CSLI.
- Vasishth, Shravan and Lewis, Richard. 2006. Argument-head distance and processing complexity: explaining both locality and anti-locality effects. *Language* 82, 767–794.
- Wanner, Eric and Maratsos, Michael. 1978. An ATN approach to comprehension. In Morris Halle, Joan Bresnan and George Miller (eds.), *Linguistic theory and psychological reality*, Cambridge, MA: MIT Press.
- Warren, Tessa and Gibson, Edward. 2002. The influence of referential processing on sentence complexity. *Cognition* 85, 79–112.
- Wasow, Thomas. 1972. *Anaphoric relations in English*. Ph.D.thesis, Massachusetts Institute of Technology.
- Wasow, Thomas and Clausen, David. 2011. Weak crossover and informativity, slides, Stanford University.