

# THE SYNTAX-DISCOURSE DIVIDE: PROCESSING ELLIPSIS

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*Abstract.* VP-ellipsis and sluicing are forms of ellipsis that can cross a sentence boundary. We present a series of comprehension studies on these forms of ellipsis to elucidate their processing and the relation of syntactic and discourse processing. One set of studies examines the hypothesis that the representation of elided material is syntactically structured. We present evidence supporting the hypothesis and tentatively attribute the effects to sharing of the structure of the antecedent constituent, with structure building or substitution of a variable for a constituent permitted if it is licensed by the syntactic principles of the language. Another set of studies tests the hypothesis that a new utterance is preferentially related to the main assertion of the preceding utterance, which is typically a constituent high in the syntactic tree. The results suggest that discourse processing differs from syntactic processing, where the most accessible material is recent material found low in the syntactic tree. A final set of studies examines the interplay of the syntactic processor, which may not violate “islands,” and the discourse processor, which may, in the processing of ellipsis sentences involving islands. A novel explanation is offered for the observation (Ross 1967) that sluicing out of relative-clause islands is grammatical except when sprouting is required.

## 1. Introduction

Speakers and writers often omit material when they produce language. Listeners and readers must somehow cope with the elided (omitted) material. In effect, they must parse and interpret silence. Understanding how comprehenders interpret ellipsis is important for any theory of language comprehension for practical reasons because ellipsis is pervasive and for theoretical reasons because it is a challenge to specify how listeners and readers get an interpretation even when there is no overt material in the input. Indeed, in the linguistic literature there is a long-standing debate whether ellipsis involves a purely semantic or discourse relation between the ellipsis site and antecedent but no syntactic structure in the ellipsis site (Dalrymple, Stuart, Shieber & Pereira 1991; Hardt 1993, 1999; Shieber, Pereira & Dalrymple 1999) or whether syntactic structure is required in the ellipsis site, along with a syntactically (LF-) identical antecedent (Sag 1976, Williams 1977, Fiengo & May 1994). A third possibility is that syntactic structure is required at the ellipsis site, but

\* This work has benefited from helpful discussion with numerous people, especially Chris Kennedy, Bill Ladusaw, Jason Merchant; our colleagues Kyle Johnson, Angelika Kratzer, Chris Potts, Lisa Selkirk; and many current and former students: Luis Alonso-Ovalle, Jan Anderssen, Ana Arregui, Katy Carlson, Mike Walsh Dickey, Shawn Gaffney, Mako Hirotani, Helen Majewski, and Paula Menendez-Benito. This work was supported by grants NIH HD-18708 and NSF BCS-0090674 to the University of Massachusetts.

ellipsis is licensed by semantic identity (Merchant 2001, 2005; Rooth 1992; Romero 1998; Kennedy 2003). In terms of linguistic theory, these three positions are distinct. In terms of processing, however, the difference between the latter two positions is less clear: if the processor needs to construct syntactic structure at the ellipsis site from silence, presumably it needs a syntactically identical antecedent in order to do so.<sup>1</sup> Thus, in our discussion, we are concerned primarily with whether syntactic structure is present at the ellipsis site. Before leaving the issue, however, we should note one further position in the literature. Kehler (2000) presents an elegant theory of ellipsis in which a syntactically matching antecedent is required only in cases of resemblance discourse-coherence relations, not in cases of, say, causal discourse-coherence relations. We discuss the discourse-coherence theory at length elsewhere and, for present purposes, simply note that our experimental tests of the theory did not support it (see Frazier & Clifton 2005; also see fn. 1).

In the present paper, we focus on forms of ellipsis such as VP-ellipsis (*John laughed. Bill did [] too.*) and sluicing (*Someone left. Tell me who [].*) that may occur within a sentence or across sentence boundaries. (For the processing of other types of ellipsis, see Carlson 2001, 2002.) The goal is not only to further the understanding of ellipsis and of processing ellipsis but also to investigate the relation between syntactic and discourse processing. Given that both syntactic and discourse processes contribute to the comprehension of the types of ellipsis we study, they provide rich grounds for developing and testing ideas about the syntax-discourse interface.

We begin by presenting novel psycholinguistic evidence supporting our representational assumptions about ellipsis. We then address our central thesis, which is summarized in (1). This proposal highlights representational (1a–c) and processing differences (1d,e) between the syntactic system and the discourse system. The left-hand column of (1a–c) lists relatively uncontroversial assumptions about the nature of syntactic representations: they are hierarchically organized projections of syntactic categories, forming a sentence. The right-hand column of (1a–c) lists likely properties of discourse representations: they are partly hierarchical structures that may include more than one sentence and that include “information structure” properties (see Birner & Ward 1998, Prince 1998, Vallduvi & Engdahl 1996 for discussion of information structure).

<sup>1</sup> Arregui, Clifton, Frazier, and Moulton (2005) present evidence that readers are willing to accept examples of VP-ellipsis without a matching antecedent under certain circumstances. This is attributed to the processor building the requisite VP antecedent at LF using the materials at hand under conditions where the processor is repairing an error the speaker is likely to have made. When the speaker is unlikely to have made the error (e.g., erroneously remembering an active antecedent as a passive rather than the other way around), the processor is less likely to accept the mismatch between antecedent and elided constituent.

(1)	<u>Syntax</u>	<u>Discourse</u>
a. vocabulary	syntactic (NP, VP, etc.)	information structure (given new, main assertion)
b. structure	fully hierarchical	partly hierarchical (modal contexts, telescoping, etc.)
c. domain	within sentence	across sentence
d. salience	low in tree/recent	“high” (due to information structure)
e. islands	sensitive	insensitive

Turning to the processing characteristics in (1d,e), it is widely assumed in the syntactic-processing literature that a general preference exists favoring recent material, material low in the tree (Kimball 1973, Frazier 1978, Gibson 1998).<sup>2</sup> It is also assumed that syntactic processing respects islands (see in particular Traxler & Pickering 1996).

What we will try to establish is that discourse processing favors information that is part of the main assertion, typically a constituent “high” in the tree, not a constituent low in the tree. In short, operations on the discourse representation, we propose, exhibit salience relations that are distinct from those in the syntactic representation. We also examine sentences that contain an interrogative constituent (e.g., *what*) followed by an elided clause. An example of such “sluicing” sentences is *He won something but I don’t know what* (see Chung, Ladusaw & McCloskey 1995 and Merchant 2001 for the syntactic analysis of sluicing; see Frazier & Clifton 1998a for experimental research on processing sluicing). We focus on sentences that contain syntactic island violations. A conventional example of an island violation is *\*What did they hire someone who won?* It is not possible to extract the object (*what*) from the relative clause *who won what*. However, such extraction may be possible in sluicing sentences, like *They hired someone who won something [but] I don’t know what* (see Chung, Ladusaw & McCloskey 1995, Merchant 2001, and experiment 8 for further discussion). We suggest that, in sluicing, a dependency between the interrogative and a variable might be formed by a nonmovement relation—in particular, a relation that is identified by the discourse processor. We present evidence suggesting that discourse processes operate in sluicing sentences and may violate syntactic island conditions, thus examining how syntactic and discourse processes jointly contribute to the processing of sentences with island violations.

The existing literature on processing ellipsis, especially verb phrase ellipsis (VPE), contains extensive analysis of a phenomenon that is similar in some respects to the phenomena we examine. Hankamer and Sag (1976) propose

<sup>2</sup> We acknowledge that there has been substantial controversy about how syntactic processing takes place and about whether there is in fact a sharp divide between syntactic and discourse processing (see, e.g., MacDonald, Pearlmuter & Seidenberg 1994; Frazier 1995). There is less controversy about the contrast between the structural properties of syntactic versus discourse representations, which is central to our hypothesis. We wish to pursue the possibility that this clear contrast is reflected in processing distinctions rather than prejudging the issue by assuming that no such distinctions exist.

that there is a basic distinction between surface anaphora, which requires a linguistic antecedent, and deep anaphora, which takes a conceptual antecedent (though see also Sag & Hankamer 1984).

- (2) The garbage needed to be taken out.
- a. John did it.
  - b. \*John did.  
Someone took out the garbage.
  - c. John did it.
  - d. John did.

The deep anaphor *did it* in (2a) is acceptable even though no linguistically parallel antecedent is present. But the surface anaphor (VPE) in (2b) is not acceptable because a linguistically parallel antecedent is not available. Tanenhaus and Carlson (1990) report a series of experiments on discourses like those in (2). Whereas comprehension times generally were shorter for “anaphors” with parallel antecedents than for those with nonparallel antecedents, acceptability judgments (the percentage of acceptable responses) showed a larger effect of parallelism for surface anaphors than for deep anaphors (see also Simner, Garnham & Pickering 2003).

Treating VPE as distinct from deep anaphora fits well with the present proposal. Although as mentioned previously VPE is at times treated as a purely semantic or discourse process (Hardt 1993, 1999; Dalrymple et al. 1991; Shieber, Pereira & Dalrymple 1999; Ginzburg & Sag 2000), we assume—and will attempt to show—that there is syntactic structure present at the ellipsis site. This suggests that VPE is not simply a form of anaphora. The findings of Ward, Sproat, and McKoon (1991) reinforce this conclusion. They explored the anaphoric-island condition (Postal 1969), which bans anaphora into (or out of) a word, as illustrated in (3).

- (3) a. Hunters of deer tend to like them. (them = deer)  
b. \*Deer hunters tend to like them. (them = deer)

In self-paced reading experiments, they tested pronouns (*they*) referring back to an object NP (*deer* in *hunted deer*) or to a word inside a compound noun (*deer* in *deer hunting*) under circumstances where the antecedent (*deer*) was salient in discourse (topical) or not (nontopical). They found that discourse salience, not the syntactic form of the antecedent, mattered. By contrast, for surface “anaphors” (*do so*), the syntactic form of the antecedent, not discourse salience, mattered. Of course, the deep and surface anaphora distinction is not the same as the distinction between semantic and syntactic accounts of ellipsis. However, the finding that surface “anaphors” involving VPE show strong syntactic parallelism effects does fit well with syntactic accounts of ellipsis.

In early psycholinguistic work, the emphasis was on studying examples of unambiguous ellipsis, usually comparing discourses containing a parallel

antecedent with those lacking a parallel antecedent. In what follows, we first address the question of whether psycholinguistic evidence supports the claim that there is syntactic structure at the ellipsis site using different sorts of tests. Then we investigate the preferred interpretation of ambiguous ellipses and the underlying reasons for the preferred interpretations. Our work differs from earlier work, which has focused on the nature of the antecedent for the ellipsis and not on the nature of the ellipsis site itself. If ellipsis is really a form of anaphora on a par with pronominal anaphora, then we would not expect internal syntactic structure at the ellipsis site. However, on approaches where ellipsis results from not phonologically pronouncing (or parsing) a constituent (the VP in VPE, a clause in sluicing; Merchant 2001, *in press*) the syntactic structure of the elided constituent is present. Indeed on this latter approach, the nonphonological representation of the elided constituent is on a par with the representation of its pronounced counterpart. Finally, with respect to islands, we examine well-studied islands for extraction, such as relative clauses and subjects. The reason for examining island violations is that they enable us to assess the respective contributions of syntactic processes and discourse processes in comprehending ellipsis.

We are obviously not the first to examine the relation between syntactic and discourse processing. However, we do believe that our approach of attempting to identify distinct representations and different processes in syntactic and discourse processing, and the coordination of these representations and processes, is novel. Some lines of very relevant research do exist, such as the work by Ward, Sproat, and McKoon (1991) discussed earlier, and the attempt to analyze how different connectives between clauses affect how linguistic material is held in memory and processed (Bever & Townsend 1979, Townsend & Bever 2001). A substantial body of research attempts to demonstrate that discourse-based decision processes are actually responsible for phenomena that have been attributed to syntactically based processes (research on issues of referential relations among noun phrases and presupposition violations; Crain & Steedman 1985 and much subsequent work in Referential Theory). But it appears that the vast majority of research on discourse processing simply does not address the issues we raise. It addresses legitimate issues—for example, the nature of inferences made to connect together the isolated propositions introduced by individual sentences, the nature of the memory processes that serve to “reinststate” backgrounded information when it is needed, and the processes by which readers and listeners identify the structure that underlies a coherent text—but these issues are not the ones we raise in the present paper.

The experimental portion of the present paper contains three distinct sections. Section 2 presents evidence that syntactic structure is present for elided material. In earlier work (Frazier & Clifton 2001) we argued that the amount of syntactic structure at the ellipsis site does not influence processing complexity. We attributed this to an essentially cost-free copying mechanism and integrated it into an account of ellipsis where it is assumed that the elided constituent has internal syntactic structure. However, one might worry that the

result is also expected on an alternative view where the ellipsis site is like a pronoun and has no internal syntactic structure. Obviously, in this case, comprehenders would not construct syntactic structure at the ellipsis site. The studies described in section 2 argue against this possibility.

Section 3 reports several studies testing the hypothesis that there is a preference for discourse processes to favor relations involving the main assertion of the first sentence, contrasting with a recency preference in syntactic processes. The studies in this section generally induce discourse processes by presenting a reader with a two-sentence discourse. The basic idea is that whatever preference is observed for an antecedent within a sentence, a comparable two-sentence discourse will typically result in more high (main assertion) antecedents than the one-sentence counterpart. At the outset we should note that the one- versus two-sentence manipulation is used for practical purposes. In fact, along with others (Kamp & Reyle 1993), we believe that a discourse representation exists even for a single sentence (see Frazier & Clifton 2002). What we think changes across a sentence boundary is not the existence of a discourse representation but the accessibility of the syntactic representation relative to the discourse representation.

These studies thus set the stage for section 4, which examines the respective contributions of syntactic and discourse processes in comprehending various kinds of sluicing sentences with island violations. This section addresses the question of how syntactic structure can be built and how dependencies involving variables can be assigned. Specifically, we suggest that discourse processing is relatively insensitive to the presence of syntactic “islands” (e.g., complex NPs), in contrast to syntactic processing. The discourse processor, we argue, can go inside an island to find the antecedent of a “sluice,” whereas the syntactic processor cannot. The proposed division of labor would help to explain why island violations are acceptable for one class of sluicing sentences but not another.

## **2. Syntactic Structure for the Elided Material**

In earlier work (Frazier & Clifton 2001) we argued that the cost of copying a syntactic (Logical Form [LF]) constituent does not depend on the size of the constituent per se—for example, the size of the VP antecedent for VP-ellipsis. This may be modeled by either a copying mechanism, an operation whose cost is not dependent on the amount of structure copied, or by structure-sharing, whereby the structure of the antecedent is shared and serves as the missing constituent at the ellipsis site, modulo any syntactic changes required for grammatical well-formedness (e.g., introducing a variable where a binder requires one). However, the absence of complexity effects due to the size of the copied or shared constituent raises the question of whether in fact a different, purely semantic view of ellipsis might be correct. We take up that possibility here and present evidence against a purely semantic account of ellipsis that does not postulate the existence of syntactic structure for the elided constituent.

One argument that syntactic structure is present for the elided constituent is derived from the intuitive perception of the ungrammaticality of sentences like (4a). Despite the fact that *buy* takes a goal and that *to* may express a Goal, (4a) is ungrammatical.

- (4) a. \*Max bought some presents and Fred did to Mary.  
 b. Max bought some presents and Fred did for Mary.

This follows immediately from the fact that *buy* requires its goal to be marked by *for*, as in (4b), if syntactic structure is present for the elided material. It is not clear how to explain this fact if syntactic structure is not present and only a semantic or inferential relation exists. Of course, this argument assumes that the difference between goals marked by *to* and those marked by *for* is largely idiosyncratic and not due to subtle semantic variation. As a reviewer pointed out to us, the ability of both *to*- and *for*-marked goals to occur as the first object of double-object verbs weighs against the semantic account. We note, however, that this argument, like most of the arguments we present in this paper, presents a challenge to views in which no syntactic structure is present at the ellipsis site rather than showing that such accounts are impossible.

Another linguistic argument for the presence of syntactic structure at the ellipsis site derives from crosslinguistic facts about sluicing. Merchant (2001) points out the existence of a correlation across languages. If a language permits preposition stranding in questions, as in (5) (e.g., English, Swedish, Icelandic), then it allows preposition stranding in sluicing, as in (6) where the “vbl” (the variable bound by the interrogative *who*) occurs in a prepositional phrase.

- (5) Who<sub>i</sub> did John go fishing with t<sub>i</sub>?  
 (6) John went fishing with someone but I don't know who [John went fishing with vbl].

Languages that do not permit preposition stranding in questions (e.g., German, Dutch, Greek, Russian, Polish, Bulgarian) do not permit preposition stranding in sluicing. It is not clear how the correlation would be explained if there were not syntactic structure for the elided material.

In this work we report psycholinguistic evidence that syntactic structure is present for the elided constituent.

## 2.1 Experiment 1a

The processing of conjunction appears to allow either the entire conjoined phrase to be processed or just the closer conjunct, but not just the more distant conjunct. We dub this the “conjunction domain hypothesis.” Extraction facts support the idea that the analysis of conjunction phrases permits the entire phrase to be available for extraction (as in 7a) or only the closest conjunct (the

first conjunct, given a dependence to the left, as in the marginally acceptable (7b)). However, extraction from just the distant conjunct (7c) seems impossible.

- (7) a. Who did John see \_ at the party and Mary see \_ at the office?  
 b. ?Who did John see \_ at the party and Mary see him at the office?  
 c. \*Who did John see him at the party and Mary see \_ at the office?

In experiment 1, sluicing is examined. Consider (8), where the interrogative constituent *what* must bind a variable corresponding to the object of the verb *studied* in the elided clause.

- (8) Michael studied but I don't know what [Michael studied *vbl*].

Imagine that *studied* is now placed inside a conjoined VP as in (9a,b) or a conjoined clause as in (9c,d) that contains an intransitive verb (*sleep*) and therefore no position from which the interrogative might have been extracted. This enables us to use the conjunction domain hypothesis to determine whether there is syntactic structure for the elided constituent in sluicing. Given that only the nearest conjunct is available in the syntax for extraction if extraction is out of only one conjunct, then we expect an asymmetry between the near conjunct and the far conjunct conditions on the syntactic view of the ellipsis.

- (9) a. Michael slept and studied but he didn't tell me what. VP, near conjunct  
 b. Michael studied and slept but he didn't tell me what. VP, far conjunct  
 c. Michael slept and he studied but he didn't tell me what. S, near conjunct  
 d. Michael studied and he slept but he didn't tell me what. S, far conjunct

On the other hand, if there is only a semantic or discourse representation of the antecedent, then there is no reason to expect an asymmetry.<sup>3</sup>

Sixteen sluicing sentences like those in (9) were included in a written acceptability judgment questionnaire. In two forms (9a,b), conjoined VPs occurred in the first clause, whereas in two forms (9c,d) conjoined clauses occurred. One verb (*studied*) can be transitive and thus takes an (implicit)

<sup>3</sup> In principle, the nearest conjunct might be determined with respect to either the surface position of the conjoined phrase, as we have done in the text, or the position of the copied VP in the elided clause (which would thus favor (9b,d) over their counterparts (9a,c)). If the surface position of the verb matters, this might be taken as evidence for the structure-sharing view of ellipsis, where the *what* is related to the material to its left, as opposed to a copying view where *what* is related to copied material to its right.

object, which can serve as the inner antecedent for the interrogative (the constituent in the antecedent clause that corresponds to the position of the variable in the sluiced clause). The other verb (*slept*) is intransitive and thus cannot take an object. In two forms (9a,c) the inner antecedent for the interrogative occurred in the second conjunct. In two forms (9b,d) the inner antecedent occurred in the distant/first conjunct.

Given the conjunction domain hypothesis, the near-conjunct examples (9a,c) should be rated more acceptable than the distant-conjunct examples (9b,d). If this expectation is confirmed, it implies the existence of syntactic structure at the ellipsis site: the inner antecedent for the variable is available in the closer conjunct in the syntactic representation. If there were no syntactic structure in the elided clause, a distance effect would be surprising. If only a semantic or inferential relation existed between *studied* and the interrogative, it is unclear why distance in the syntactic representation should matter. Of course, one might hypothesize that access to the discourse representation in ellipsis is mediated by the syntactic form of the antecedent—end of story. As discussed later, this account would not explain why in experiment 6 no order or recency effect is observed for main clause–subordinate clause sentences. There too syntactic form should have mediated access to the discourse representation, leading to facilitation for antecedents contained in the most recent clause.

### 2.1.1 Method

Sixteen sluiced sentences like those in (9) were constructed, with four versions of each. All items appear in Appendix F. These were included in a written questionnaire that also contained 52 other sentences of varying forms (including 12 sentences that were clearly unacceptable, as catch sentences to eliminate any participants who were obviously not following instructions). Four counterbalanced forms of the questionnaire were constructed, with four sluiced sentences in each of the four versions illustrated in (9). One randomization was made of each form.

Forty-eight University of Massachusetts undergraduates completed the printed questionnaire, working individually. They were instructed to rate each sentence on a 5-point scale, where 1 was to mean “unacceptable” and 5 to mean “acceptable and natural.” They were further instructed to assign a 1 to a sentence that they would not expect a native speaker of English to say, and 5 to a sentence that they could easily imagine themselves saying or hearing without noticing anything odd about it. They were told to try to use the whole 5-point scale.

### 2.1.2 Results and discussion

The mean ratings appear in Table 1. Sentences in which the implicit inner antecedent appeared in the near conjunct were rated as significantly more

Table 1. Mean ratings for sluicing sentences, experiment 1a: 5 = natural, 1 = unnatural; mean reading times, both unadjusted and adjusted (ms), experiment 1b

Conjoined phrases	Inner antecedent	Ratings (1a)	Reading times (1b)			
			Unadjusted		Adjusted	
			Segment 1	Segment 2	Segment 1	Segment 2
VP	Near	3.30	1,896	1,423	-67	-202
VP	Far	2.69	2,016	1,548	-1	-53
S	Near	3.41	2,247	1,437	105	-202
S	Far	2.40	2,326	1,534	301	-50

acceptable than sentences in which the inner antecedent appeared in the far conjunct ( $F_1(1, 47) = 57.79$ ,  $p < .001$ ;  $F_2(1, 15) = 40.04$ ,  $p < .001$ ). This difference was significantly greater for the S conjunction items than for the VP conjunction items ( $F_1(1,47) = 13.30$ ,  $p < .001$ ;  $F_2(1,15) = 6.03$ ,  $p < .03$ ), but there was no overall difference between S and VP conjunction items ( $F_1(1,47) = 1.49$ ,  $p > .23$ ;  $F_2 < 1$ ). The results are as predicted by the conjunction domain hypothesis and the assumption that syntactic structure is available for the elided clause, with evidence that the conjunction domain effect is more pronounced for S than for VP conjunction.

## 2.2 Experiment 1b

In experiment 1b, the experimental materials from experiment 1a were tested in a self-paced reading study.

### 2.2.1 Method

2.2.1.1 *Materials.* Four versions of each of the 16 sentences illustrated in (9) were assigned to four counterbalanced forms, where they were combined with 104 other items (some fillers, some from other experiments), resulting in four 120-item lists. Each experimental sentence was divided for presentation into two segments, as illustrated in Appendix A. Half the items were followed by two-choice questions, which tested various pieces of information from the sentence and were intended simply to encourage careful reading.

2.2.1.2 *Subjects and procedures.* Forty-eight University of Massachusetts undergraduates were tested in individual half-hour sessions. On each trial, a ready signal appeared on a computer-controlled video screen. When the subject pulled a response lever, a preview of where letters would appear was presented as underscore marks on the screen. The next pull of the lever then caused the first sentence to appear in place of the underscores, while the next pull caused the displayed sentence to disappear and be replaced by

underscores and the second presentation segment to appear (the final sentence, or in versions b and d, the final two sentences, including the elliptical sentence). Half of the sentences were followed by a comprehension question with two alternative answers, and subjects were instructed to pull a response lever under the answer that they considered correct. The times to read each presentation segment and to answer the question were recorded.

An experimental session began with a practice list of eight sentences. It continued with an individually randomized presentation of the 120 experimental sentences.

### 2.2.2 Results

The reading times for each presentation segment appear in Table 1 (after eliminating times over 8,000 or under 100 ms; less than 1%). The table shows both unadjusted reading times (in ms) and times corrected for length using individual linear regression equations (Ferreira & Clifton 1986; see also Trueswell, Tanenhaus & Garnsey 1994). Both showed the same pattern of effects, but the significance levels were higher for the latter measure because of reduced between-item variability and will therefore be reported.

Reading times for the final clause of the sentences (*but he didn't tell me what*) were longer for the distant conjunct (9b,d) example than for the near conjunct (9a,c) examples ( $F_1(1,47) = 17.81, p < .001$ ;  $F_2(1,15) = 7.08, p < .02$ ). The effects of VP versus S conjunction and the interaction of type and order of conjunction were nonsignificant ( $F < 1$ ).

### 2.2.3 Discussion

The results of studies 1a and 1b support the conjunction domain hypothesis: sluicing sentences with inner antecedents in the near conjunct were rated more acceptable, and processed faster, than those with distant conjunct inner antecedents. This strengthens existing evidence that syntactic structure is present at the ellipsis site. Of course, one might still try to develop an account based on anaphora. However, we do not think an anaphoric account is particularly promising for several reasons. In general, anaphoric dependencies can span rather large distances without incurring any processing penalty (Clifton & Ferreira 1987, for example). Also, McKoon, Ward, Ratcliff, and Sproat (1993) compared ellipsis (*do so*) with anaphora (*do it*), finding effects that dissociated the two: for anaphora, topicality mattered, as in the Clifton and Ferreira study and other studies of anaphora, whereas for ellipsis, it was syntactic parallelism that mattered, not topicality. Indeed, if the order of conjuncts matters at all for purposes of finding an antecedent for a pronoun, it is the first, not the second,

conjunct that seems to be favored (Gernsbacher 1989, but also Gordon & Hendrick 1998).<sup>4</sup>

One discrepancy between experiments 1a and 1b is the significant interaction present only in 1a. In acceptability judgments, the distance effect was larger for conjoined clauses than for conjoined VPs, whereas in reading times the effect is equally large for conjoined clauses and conjoined VPs. We suspect that all constituents of the most recent clause are relatively accessible, which may give rise to a slightly weaker distance effect within the most recent clause, detectable in ratings but not in reading times.

### 2.3 Experiment 2

One of the classic problems in an account of VP-ellipsis is the regress problem in antecedent-contained deletion (ACD). Consider (10).

(10) Dulles suspected everyone who you did [e].

If the elided VP in (10) were interpreted with respect to the underlined VP, the resulting interpretation would be: *Dulles suspected everyone who you did* (*suspect everyone who you did* [*suspect everyone...*]). In short, an infinite regress would occur.

May (1985) proposed that the infinite regress problem should be solved by quantifier raising (QR), as in (11).

(11) Dulles [<sub>AgrO</sub> [<sub>DP<sub>i</sub></sub> everyone who you did [<sub>VP</sub> [e]]][<sub>VP</sub> suspected  $t_i$ ]]

After QR raises the DP, the VP *suspected*  $t_i$  can serve as the antecedent for the elided VP at LF. No regress occurs.<sup>5</sup>

The mere existence of ACD is a challenge to purely semantic or discourse accounts of ellipsis (May 1985, Kennedy 1997). Thus we think linguistic arguments favor an account of ellipsis that depends on syntactic representation. We wish to further bolster such arguments by showing that an account of the complexity of processing ACD is readily available on the assumption that

<sup>4</sup> One reviewer, concerned about the anaphora possibility, pointed out to us that sentences like those below might also show a distance effect, in the absence of ellipsis.

- (i) Michael slept and studied (something) but he didn't tell me what he studied.
- (ii) Michael studied (something) and slept but he didn't tell me what he studied.

We have not formally tested these sentences, but our own intuitions do not find a contrast as large as that with ellipsis.

<sup>5</sup> More recent analyses in the minimalist framework preserve the basic insight of May but attribute the movement of the DP to movement at LF to Agr<sub>O</sub> for purposes of Case assignment; see Hornstein 1994 for empirical arguments that the resulting analysis is superior to one based on QR. However, Kennedy (1997) presents strong arguments against the Case-based account and our results also argue against this alternative. Given that a phrase always requires Case on the Hornstein analysis, immediate movement should occur regardless of whether VP-ellipsis occurs in the relative clause.

syntactic structure is present for the elided constituent and that (long) QR is optional.

For present purposes, what is interesting is that the processor is faced with a chain where it appears that the phrase *everyone who you did [e]* may be interpreted either in its surface position, that of the tail of the chain, as in (12a) or at the LF/Case position, the head of the chain, as in (12b).

- (12) a. Dulles [<sub>AGR</sub>O *t<sub>i</sub>* [<sub>VP</sub> suspected [<sub>DP<sub>i</sub></sub> everyone who you did <sub>VP</sub> [*e*]]]].  
 b. Dulles [<sub>AGR</sub>O [<sub>DP<sub>i</sub></sub> everyone who you did [*e*]]]<sub>VP</sub> [suspected *t<sub>i</sub>*].

By hypothesis, the processor will initially choose to interpret the DP in its surface position (at the tail of the chain).<sup>6</sup> This means the processor will copy the VP underlined in (10). See Tunstall 1998 and Anderson 2004 for independent evidence that the processor interprets phrases in surface position when possible—that is, when no evidence warrants interpretation at other positions in a chain. In (12a), when the processor encounters the elided VP, it will not have a VP of the right shape to serve as the antecedent VP. Consequently, the processor will need to interpret the DP in its higher position, as in (12b).

In general, structures are harder to reanalyze the longer the initial structure has been retained (Christiansen, Holingworth, Halliwell & Ferreira 2001; Ferreira & Henderson 1991; Frazier & Rayner 1982; Frazier & Clifton 1998b). Consequently, we might expect that delaying the evidence that an ACD sentence like (10) contains an elided VP would dramatically increase processing difficulty. Of course, to test this prediction, late disambiguation ACD sentences must be compared to relevant control sentences.

Experiment 2 examined items like those in (13).

- (13) a. Dulles investigated some men Bill said you did.  
 b. Dulles investigated some man you did, Bill said.  
 c. Dulles investigated some man Bill said you investigated.  
 d. Dulles investigated some man you investigated, Bill said.

Item (13a,b) contain elided VPs; (13c,d) are their overt counterparts. In (13a) and (13c) the target VP (elided in 13a, overt in 13c) is embedded under the clause *Bill said*. In (13b,d), this clause is present to control for number of clauses and propositional complexity, but it is outside the relative clause and is the root clause of the sentence. In short, focusing on the critical relative clause, we have crossed +ellipsis (13a,b) versus –ellipsis (13c,d) with

<sup>6</sup> Throughout, we limit our discussion of QR to long QR, as in the text. It is well known that a type-fixing operation must also occur to avoid a type mismatch that would preclude composition of the quantified noun phrase and the VP. We assume that the type-fixing operation is obligatory but either is not QR or does not leave a variable of the appropriate sort for an antecedent VP.

two-clause (13a,c) versus one-clause (13b,d) relative clauses. The main prediction is that (13a) will be rated worse (more unnatural) than (13b), relative to their controls. We expect an interaction, with (13a) being particularly unnatural, because the need to interpret the DP in its higher (LF Case) position is not apparent until late, indeed, one clause after the highest clause in the DP.

### 2.3.1 *Method*

Sixteen items like those in (13) were constructed, with four versions of each, defined by the factorial combination of ellipsis present versus absent and two-versus one-clause relative clauses. All items appear in Appendix B. These items were combined with 16 other items like *John bought an X-large t-shirt and a small one* into four counterbalanced forms of a questionnaire. Each form of the questionnaire contained four experimental items in each of the four versions; across the four questionnaire forms, each item was tested once in each version.

Seventy University of Massachusetts undergraduates completed the questionnaire individually after having participated in an unrelated experiment. They were asked to decide how natural each sentence sounded to them, from the perspective of helping a nonnative speaker of English to learn what was natural. Each sentence was followed by a 5-point rating scale, where 1 was defined as “unnatural” and 5 as “natural.”

### 2.3.2 *Results and discussion*

The mean ratings appear in Table 2. Elliptical sentences were rated as less natural than nonelliptical sentences ( $F_1(1, 69) = 48.89, p < .001$ ;  $F_2(1, 15) = 15.68, p < .001$ ). Most importantly, the interaction between presence versus absence of ellipsis and two versus one clauses in the relative clause was significant ( $F_1(1, 69) = 10.22, p < .002$ ;  $F_2(1, 15) = 10.71, p < .01$ ). The long (two clause) ACD sentence was rated as most unnatural, whereas adding a second clause to the nonelliptical (and thus non-ACD) sentence did not lower its rating.

We think the results suggest that QR is optional. The processor first tries the surface VP as the antecedent and only later performs QR. Thus, on the first analysis, the copied or shared structure has the wrong form to serve as an antecedent.

*Table 2. Mean naturalness ratings, experiment 2: 5 = natural, 1 = unnatural*

Relative clause	Ellipsis	
	Present	Absent
Two clause	1.99	2.60
One clause	2.28	2.48

The account provided for the results of experiment 2 clearly presupposes that syntactic structure is available at the ellipsis site. Having discovered the inadequacy of the first copied or shared VP, the one without a variable, the appropriate antecedent VP is created by quantifier raising the DP, thereby creating an antecedent VP containing a variable. It is not at all clear how one could give an explanatory nonsyntactic account of the results.

It is surprising that readers prefer the unelided form of these sentences. Presumably this is because the sentences are rather complex. Also, as one reviewer pointed out, ACD may be preferred in sentences with a DP headed by a strong quantifier rather than an indefinite.

### 2.4 Experiment 3

The role of island constraints in ellipsis is discussed in section 4 with respect to the interplay of syntactic and discourse processing. However, here we wish to note that accounts where there is syntactic structure at the ellipsis site could easily accommodate the observation that ellipsis sentences with island violations are less acceptable than their non-island violating counterparts. Although syntactic accounts exist which permit ellipsis sentences with island violations (see Merchant 2005 for an account where island violations are repaired if the constituent marked as “\*” [ungrammatical] is not pronounced), one might expect island-violating sentences would not be perfect—for example, a repaired sentence may not be a perfect sentence.

Experiment 3 tests the possibility that even “repaired” island-violating ellipsis sentences show some penalty in the form of decreased acceptability relative to nonisland counterparts. It required subjects to make speeded acceptability judgments on six types of sentences. Two (14a,b) contained one-clause questions out of a PP that did (b) or did not (a) involve an adjunct island violation. Two forms (14c,d) consisted of two clauses: the declarative counterpart to the question in (14a,b) followed by a clause (*but I don't know what*) that contained an elided interrogative clause. The declarative counterparts without any extraction (14e,f) served as controls.

- (14) a. What lecture was Sally impressed with?  
 b. What lecture was Sally impressed after?  
 c. Sally was impressed with some lecture, but I don't know what.  
 d. Sally was impressed after some lecture, but I don't know what.  
 e. Sally was impressed with some lecture.  
 f. Sally was impressed after some lecture.

Assuming the expected penalty for violations of the adjunct island in (b), the (b)-form should be accepted less often than the (a)-form. If the sluicing sentence in (14d) also involves an island violation, then (14d) should be

accepted less frequently than (14c). To the extent that this island violation is partially repaired by eliding or not pronouncing the offending dependency, the difference in acceptability might be smaller for the sluicing sentences than for the questions. To ensure that the results do not reflect a semantic or plausibility difference between the *with* sentences and the *after* sentences, (14e,f) were included. The only differences of interest in (14a–d) are differences above and beyond those observed for (14e,f).

### 2.4.1 *Method*

2.4.1.1 *Materials.* Twenty-four sentences like (14) were constructed, with six versions of each. These 24 sentences were combined with 114 other sentences and two-sentence discourses of a wide variety of constructions, including 32 sentences that were unacceptable for a variety of reasons (gender or number disagreement, missing or extra arguments, semantic anomaly, etc.) A six-item practice list was also constructed, with three acceptable and three clearly unacceptable items. Six counterbalanced lists were constructed, such that each list included 4 sentences in each version, and each sentence appeared on each version in one list.

2.4.1.2 *Subjects and procedure.* Forty-eight University of Massachusetts undergraduates were tested in individual half-hour sessions. Eight participants saw each of the six counterbalanced lists. Each participant was instructed to read sentences or two-sentence discourses, phrase by phrase, pulling a trigger with the right hand if the sentence was grammatically acceptable to that point, and pulling a trigger with the left hand if the sentence had become unacceptable. “Unacceptable” was defined as violating the normal rules of everyday English. It was stressed that a sentence did not have to be the most “insightful, true, interesting, or elegant” sentence the subject had ever seen to be classed as “acceptable.” To conclude the instructions, the participant then marked a sheet of 10 sentences as acceptable or unacceptable, and the experimenter discussed any differences of judgment (which were very rare).

After instructions, a session began with the randomized presentation of the six items in the practice list, followed by a break, followed by an individually randomized presentation of all 138 items in the main list. On each trial, a series of underscores appeared on the screen to indicate where the characters were to appear. In the full experiment, some items appeared all at once, whereas others were presented segment by segment. The latter was true of the sluiced experimental items (14c,d); the former was true of the other experimental items. When the participant first pulled the right-hand trigger, some or all of the experimental item appeared on the screen, replacing the underscores. The subject then pulled a response trigger to indicate the acceptability of the item, and if a part of the item remained, the first part disappeared and the second part appeared, in which case the subject pulled a response trigger again. A right-hand trigger pull indicated

that the item was acceptable, and a left-hand trigger pull indicated that it was unacceptable. The participant's response and reaction time were recorded.

#### 2.4.2 Results

The mean reaction times and the proportion of "acceptable" responses appear in Table 3. The reaction time data yielded nothing of interest. Analyses of variance indicated that there was a main effect of type of sentence (question, sluice, control), but this reflected nothing other than the fast times to respond to the relatively short sluice clause, as compared to the time to respond to the entire sentence in the other conditions.

The analysis of proportions of "acceptable" responses, however, indicated significant main effects of both factors (type of sentence, argument vs. adjunct) and their interaction. Control sentences were accepted more often than questions, which were accepted more often than sluices ( $F_1(2,94) = 16.38, p < .001$ ;  $F_2(2, 46) = 17.58, p < .001$ ). Sentences with arguments were accepted more often than sentences with adjuncts ( $F_1(1,47) = 26.71, p < .001$ ;  $F_2(1, 23) = 14.59, p < .002$ ). Of most interest, the size of the argument-adjunct effect differed across sentence types ( $F_1(2,94) = 5.74, p = .004$ ;  $F_2(2,46) = 4.07, p = .024$ ). It was largest for the question sentences (.22), next largest for the sluices (.13), and smallest for the controls (.005).

The results clearly show that an attenuated but significant penalty persists for the island-violating ellipsis sentences. The size of this penalty would be consistent with a "repair" approach like Merchant 2005, assuming that repair is only partial. A full theory of the role of island violations in various types of ellipsis takes us well beyond the scope of this paper. The important point in the present context is that the existence of a penalty for island violations in elided constituents readily follows if syntactic structure is present at the ellipsis site. The fact that such penalties are reduced compared to penalties in unelided constituents may be accounted for by the fact that the offending dependency is not pronounced (Merchant 2005) or perhaps because it is not focused.

Table 3. Proportion of "acceptable" responses and reaction time (second region for sluicing conditions), experiment 3

Condition	Proportion "acceptable"	Reaction time (ms)
Argument question (14a)	.831	3,807
Adjunct question (14b)	.611	3,974
Argument sluice (14c)	.651	2,746
Adjunct sluice (14d)	.519	2,775
Argument control (14e)	.838	3,579
Adjunct control (14f)	.833	3,886

### 2.5 Discussion: Structure at Ellipsis Site

In section 2 we have presented linguistic and psycholinguistic evidence that syntactic structure is present for the elided material in sluicing and VP-ellipsis. Experiment 1 implicates a nearest-conjunct relation between the interrogative and the position of the variable. We think this implicates syntactic structure for the elided material for two reasons. First, the nearest-conjunct effect is also present for *wh*-extraction, which we assume to be a clear instance of a syntactic dependency. Second, order effects are apparently not robust when an antecedent is found in the discourse representation, as indicated in many studies of anaphora (Clifton & Ferreira 1987, and also by the main clause–subordinate clause results in experiment 6).

The results of experiment 2 follow naturally if quantifier raising occurs only when the processor receives evidence that it is necessary. Delaying this evidence increases the difficulty of processing sentences like (13a). If the syntactic structure of the shared constituent were not at issue in arriving at the interpretation of the elided VP, it becomes unclear why the operation of creating a variable as the object of a verb should be more difficult when the evidence for it is delayed. This argument relies on the assumption that accounting for ACD involves relating the elided VP to a VP with the appropriate syntactic shape and in turn provides evidence for that assumption in the sense that a natural account for the psycholinguistic (complexity) data follows readily given the assumption.

The nature of the argument here is not that one could never develop an account of the results of a single experiment without assuming the existence of syntactic structure for the elided material. Rather, as usual, our attempt has been to account for a variety of results in a single framework of assumptions—assumptions that led us to expect these results in advance. We do not see an obvious or natural (nonsyntactic) account for the full range of effects discussed in this paper. We thus view our proposal, and the empirical evidence supporting it, as a challenge for nonsyntactic accounts.

In section 2 experimental evidence has been presented in support of the claim that syntactic structure occurs in the ellipsis site. Assuming that it is typically copied from an already occurring antecedent, the question for an account of processing ellipsis is how the processor chooses among potential antecedents. This is the question taken up in section 3.

### 3. “Salience” Relations

When processing discourse, readers and listeners may prefer interpretations based on material high in the phrase structure tree of a sentence because of expectations concerning how information is packaged and where important information is expected to occur. Perhaps the clearest examples involve relative clauses. Compare the sentences in (15).

- (15) a. The man who wore a red tie approached a woman.  
 b. The man who approached a woman wore a red tie.

The main assertions of (15a) and (15b) are contained in their matrix clauses (*approached a woman* and *wore a red tie*, respectively). The embedded relative clause allows the perceiver to identify a referent by predicating information of its head. Readers know that (15a) and (15b) are not interchangeable. Similarly in *John found out that the man approached a woman*, the main assertion is that *John found out p* not that *the man approached a woman*.

We propose the main assertion hypothesis in (16).

- (16) Main assertion hypothesis:  
 Other things equal, comprehenders prefer to relate material in a new sentence to the main assertion of the preceding sentence.

The main assertion hypothesis is intended to capture the reader's expectation that material contained in the matrix clause will be the preferred antecedent for VPE. We do not claim that the main assertion tendency is limited to ellipsis. For instance, a substantial body of research on the use and interpretation of personal pronouns demonstrates that a pronoun takes as its preferred antecedent a "center" of the preceding clause or sentence (Gordon & Hendrick 1998; Grosz, Joshi & Weinstein 1995), and the center must be part of the main assertion. Similarly, we do not claim that the main assertion hypothesis, taken by itself, is novel. The centering hypothesis, just mentioned, is closely related to the main assertion hypothesis, and the hypothesis can be seen as a variant of a commonplace in prescriptive rhetoric: Stick to the topic. What is new is the claim that the main assertion hypothesis applies in the domain of discourse representations but not in the domain of syntactic representations.

Even this claim has its precursors. In the pioneering days of modern psycholinguistics, many ingenious studies probed the nature of the memory representation for linguistic material after the material had initially been processed. The work suggested that the syntactic form of an utterance is lost more rapidly than its meaning (Sachs 1967) and that syntactic detail becomes inaccessible across a clause boundary (e.g., Caplan 1972, Jarvella & Herman 1972). Many results supported the idea that processing takes place clause by clause (see Fodor, Bever & Garrett 1974). In fact, however, these studies just show that clause boundaries have effects on the availability of linguistic information. The study that most clearly raises questions about claims about what is accessible in a discourse and shows that the main assertion of a sentence is more accessible than its other content is a little known study by Walker, Gough, and Wall (1968), described by Fodor, Bever, and Garrett (1974). Sentences like (17) were tested in a two-word probe experiment. Participants responded more slowly if the two probe words were drawn from

different clauses (*Indians, killed*) than if they were drawn from the same clause.

(17) The scout the Indians saw killed a buffalo.

They were also faster if the two words came from the matrix clause (*scout, killed*) than if they both came from the embedded clause. The matrix clause, of course, presents the content of the main assertion of the sentence. This result suggests that once a sentence has been processed, the main assertion is the most accessible or salient part of the sentence.<sup>7</sup>

### 3.1 Experiment 4

Consider (18a). We assume that the phrase *and Mary did too* is preferentially attached low for syntactic reasons. This phrase is conjoined with the clause *Fred went to Europe*. Presumably, this attachment must be revised to compute the matrix antecedent interpretation (in which Mary said something).

- (18) a. John said that Fred went to Europe and Mary did too.  
 b. John said that Fred went to Europe. Mary did too.

Within a sentence, we assume that the syntactic (including LF) representation is readily accessible. In the syntax we expect recent material to be favored over distant material for purposes of both attachments, favoring attachment to a low recent node, and for finding a preferred antecedent for ellipsis (a low recent constituent). Across sentence boundaries, as in (18b), the syntactic representation will be less accessible. The discourse representation will be more accessible, and antecedents in the position where important information is expected (e.g., in positions high in the tree) will be favored. These predictions were tested in a written questionnaire study.

Before turning to the study, it is important to emphasize that salience of the potential antecedents is not the only factor that should be expected to influence the choice of antecedent. Imagine that the plausibility or likelihood of the reading resulting from the selection of one particular antecedent is much greater than the plausibility of the other. On anyone's model of sentence processing, this should be expected to influence the ultimate choice of antecedent. So, the predictions concerning the relative salience of antecedents are not predictions that should be construed in terms of a majority of one type of response or a majority of the other type, given that the baseline level of, say, matrix VP antecedents will be influenced by plausibility. Instead, the

<sup>7</sup> We have no doubt that ultimately information-structure-based preferences will be more complicated than suggested so far. But what is important for present purposes is not a fully fleshed out account but rather a test of the hypothesis that information-structure-based preferences such as the main assertion preference need not coincide with the general syntactic preference for material low in the syntactic tree.

predictions must be construed in terms of the baseline level of matrix VP antecedents (VP1 antecedents) being greater in the across-sentence condition than in the within-sentence condition.

### 3.1.1 Method

3.1.1.1 *Materials.* Twelve examples were constructed, with two versions of each, as illustrated in (18). Each example consisted of three clauses with VP-ellipsis in the third clause. The two versions of an example differed only in whether the final claim was conjoined to the preceding clause or appeared as a separate sentence. The resulting sentences (which appear in Appendix D) were included in a questionnaire with an additional 20 sentences that had quantifier scope ambiguity (e.g., *In the movies, a man loved every woman*). Each sentence was followed by a two-choice response (e.g., (18) was followed by *What did Mary do? [1] went to Europe [2] said Fred went to Europe*). Four forms of the questionnaire were constructed, each with six examples of sentences like (18) presented as single sentences and six as two-sentence discourses, counterbalanced across the two forms and independently randomized for each form.

3.1.1.2 *Participants and procedures.* Twenty University of Massachusetts undergraduates completed the questionnaire for course credit. They were instructed to read each sentence or two-sentence discourse, decide what it meant to them, and then read and answer the following question. They were asked to check the answer that they thought the sentence first meant to them and were told not to puzzle over the frequently ambiguous sentences. Each participant completed the questionnaire individually, at his or her own pace.

### 3.1.2 Results

For the items presented as single sentences, 60% of the responses indicated that a lower (embedded clause) antecedent was selected. In the two-sentence condition, a significantly smaller percentage of the responses (45%) indicated the lower antecedent ( $t_1(1, 19) = 2.35, p < .03$ ;  $t_2(1, 11) = 3.10, p < .02$ ).

### 3.1.3 Discussion

The prediction that more recent material is preferred as the antecedent of an ellipsis within a sentence but the discourse-salient (higher) material is preferred across sentences was confirmed. Assuming that a multiple-sentence discourse (as opposed to presenting the same material in a single sentence) emphasizes the discourse representation, this finding supports our proposal that salience relations differ between syntactic and discourse representations—specifically, that syntactic representations govern availability within a sentence, but discourse representations dominate across sentence boundaries.

One might be concerned that the results of experiment 4 are entirely due to the effect of recency on syntactic attachment rather than the relative salience of main assertions across rather than within sentences. If there is a preference in syntactic processing to attach new material to recently processed material, the elliptical *and Mary did too* might be coordinated with the recent phrase *Fred went to Europe*, which would effectively force it to take the low antecedent. Syntactic coordination is not involved in interpreting the two-sentence discourses, which removes this reason to choose a low-antecedent interpretation. We cannot reject this suggestion on the basis of experiment 4 (or 5). However, experiments 6 and 7 do address the relative accessibility of main assertions under conditions where no attachment ambiguity is present. We note further that the results of Walker, Gough, and Wall (1968) suggest that the main assertion of an unambiguous sentence has priority in memory after the sentence has been processed, which justifies the basis for our proposed account of the results of experiment 4.

One might be concerned whether the lower preferences observed in experiment 4 are formed during ordinary, rapid reading versus being limited to the kind of reflective processing that can take place while completing a written questionnaire. Experiment 5 explored this possibility, as well as investigating the effect of adding a context that pragmatically biased readers toward or away from a matrix interpretation of an ellipsis.

### 3.2 Experiment 5

Experiment 5 presented sentences in contexts that pragmatically biased readers to either a matrix or an embedded-VP interpretation of ellipsis, as illustrated in (19) and (20), and measured reading times and interpretations using a self-paced reading procedure designed as a further test of the main assertion tendency. The initial sentence in (19) and (20) contains an indirect question querying who went where for vacation. The matrix subject of the query in (19), *John wondered...*, is singular, imposing an embedded-VP antecedent bias (a “low” bias), whereas in (20), *John and Fred wondered...*, it is plural, imposing a matrix-VP antecedent bias (a “high” bias).

- (19) John wondered who went where for their vacation. (low bias)
- a. John said Mary went to Europe and Fred did too. (one sentence)
  - b. John said Mary went to Europe. Fred did too. (two sentences)
- (20) John and Fred wondered who went where for their vacation. (high bias)
- a. John said Mary went to Europe and Fred did too. (one sentence)
  - b. John said Mary went to Europe. Fred did too. (two sentences)

The main assertion hypothesis predicts more matrix-VP antecedents in the two-sentence conditions (see (19b) and (20b)) than in the one-sentence conditions (see (19a) and (20a)). If the bias from the context sentence is effective, there should also be more matrix-VP antecedents in (20) than in (19).

Reading times and question-answering times were recorded in experiment 5. The primary purpose was to discourage participants from ruminating on the possible meanings of the discourses. However, the time data were examined to explore the possibility that contextual bias conspires with the inherent bias of the discourse form (one sentence vs. two) to affect speed of comprehension. For instance, one might expect a reading-time advantage for (19b) and (20b), where the two sources of bias are congruent, relative to their counterparts (see (19a) and (20a)), where the inherent bias of the discourse form conflicts with the contextual bias.

### 3.2.1 Method

Four versions of each of 16 two- and three-sentence items were made up on the model of (19) and (20). All appear in Appendix E. The initial sentence of two versions (a and b) began with a single proper-name subject, whereas the initial sentence of the other two versions began with two conjoined proper names (presumably biasing interpretation toward the matrix antecedent of the elided VP, since the second proper name occurred as subject of the ellipsis). In versions (a) and (c), the complement of the verb of saying appeared as a single conjunction of two clauses, and in versions (b) and (d), it appeared as two separate sentences. The latter version presumably would bias toward matrix interpretations, following the main assertion hypothesis. These sentences were assigned to four counterbalanced lists, with four instances of each version in a list. The list contained 78 other sentences and two-sentence discourses of a variety of different forms.

Experiment 5 was run concurrently with experiment 1b, so all procedures described there apply here.

### 3.2.2 Results

The reading times and proportions of high attachment (main clause) answers together with question-answering times (pooled over both answers) appear in Table 4. The time measures proved generally uninformative. In reading times for the second presentation segment, no effect approached significance (all  $F < 1$ ). Although both main effects (subject plurality, conjoined vs. separate sentences) were nonsignificant in the analysis of question answering time ( $F < 1$ ), the interaction between the two factors was significant by subjects but not by items ( $F_1(1,47) = 4.47, p < .04$ ;  $F_2(1,15) = 2.25, p < .16$ ). Question-answering times (pooled over both high- and low-attachment answers) may have been longer in the singular subject, conjoined sentence case and the

Table 4. Mean reading times and question-answering times (ms) and proportions of high-attachment answers, experiment 5

Condition	Measure			
	Time		Question time	Proportion high attachment
	Region 1	Region 2		
A (single subject, conjoined sentence)	2,755	3,407	2,742	.263
B (single subject, two sentence)	2,723	3,442	2,519	.343
C (conjoined subject, conjoined sentence)	3,095	3,417	2,602	.328
D (conjoined subject, two sentence)	3,171	3,388	2,724	.444

plural subject, separate sentence case than in the complementary cases. This was precisely the opposite of the result predicted for sentence reading time: Faster times when the initial sentence subject and the conjoined versus separate nature of the two clauses resulted in the same interpretation bias than when they had conflicting biases. We have no satisfying account of this finding.

In contrast, the proportions of different answers chosen do help us evaluate our hypotheses. High-attachment question answers were more frequent when the initial sentence subject had two conjoined proper names (presumably biasing toward matrix interpretation of the elided VP) than when the initial sentence had a singular proper-name subject ( $F_1(1,47) = 4.68$ ,  $p < .04$ ;  $F_2(1,15) = 11.75$ ),  $p < .01$ ). Similarly, high-attachment answers were more frequent when the elided VP was contained in a separate sentence than when it occurred in a conjoined sentence ( $F_1(47) = 5.35$ ,  $p < .03$ ;  $F_2(1,15) = 9.28$ ,  $p < .01$ ), which supports the main assertion hypothesis. The two factors did not interact significantly.

### 3.2.3 Discussion

The question answers in experiment 5 provide further evidence for the main assertion hypothesis. In experiment 4, questionnaire results suggested more matrix-VP antecedents for two-sentence examples compared to one-sentence examples. Experiment 5 found similar results when participants had to read mini-discourses in a self-paced fashion, without being able to go back and reflect on the sentence. However, sentence reading times did not show any effect of bias, and question-answering times hinted that answering times were actually slower if the context matched the inherent bias of the example than if it mismatched, an admittedly statistically nonsignificant result which we are at a loss to explain. We conclude that experiments 4 and 5 support the primary predictions of the main assertion hypothesis, but leave questions about the time course of integrating different sources of information in discourse comprehension unanswered. The fact that the absolute levels of matrix-VP antecedents varied across experiments and the fact that it only reached a level of 44% in experiment 5 is really an issue concerning the baseline biases in the

materials. As noted earlier, the absolute level of matrix-VP antecedent choice is not really what is at issue; what matters is how the baseline is influenced by the inter- versus intrasentential manipulation.

The effect of sentence boundaries in experiments 4 and 5 might be influenced by implicit prosody: across sentence boundaries, readers are presumably more likely to assume the presence of an intonational phrase boundary than within a sentence. It is certainly plausible to think that discourse chunks are defined by intonational phrases rather than by periods, even in silent reading (Bader 1998, Fodor 2002). We note that Carlson, Frazier, and Clifton (2004) have presented auditory studies manipulating the presence of a continuation boundary tone (H%), which might be thought to favor the following elided clause being included in the preceding sentence, versus a low boundary tone (L%), which might favor “finality” and thus a sentence boundary before the final elided clause. Despite the plausibility of this approach, no effect of boundary tone was observed. In a later study where the same intonations were paired appropriately with syntactically disambiguated one- versus two-sentence examples (by conjoining the two clauses with *and* or *not*), the auditory results mirrored the reading results reported here: two sentences resulted in more frequent matrix-clause choices than did their one-sentence counterparts.

As noted in the discussion of experiment 4, it is possible to attribute the difference between one- and two-sentence items to a recency preference in the one-sentence items rather than to a relatively heightened availability of the main assertion in the two-sentence items. Experiment 6 addresses this concern by comparing the relative accessibility of main and subordinate assertions in discourses where syntactic attachment is not an issue, and goes on to demonstrate a recency-like effect that holds across a sentence boundary.

### 3.3 Experiment 6

Consider the sentences in (21).<sup>8</sup>

- (21) a. Mary laughed after she made a joke about the supervisor. / Then Tina did too.  
 b. After Mary laughed, she made a joke about the supervisor. / Then Tina did too.

Assuming that the main clause expresses the main assertion of the initial sentence, readers should be more likely to interpret *did too* as *laughed* in (21a)

<sup>8</sup> Some colleagues have suggested that discourses like those in (21) may be prohibited by the grammar. We are not aware of any grammatical proposal that would exclude examples like these. Further, in a mini-discourse like (i), without any ambiguity, the sentence seems quite acceptable, as would be expected if processing factors are responsible for the intuition that (21) is degraded.

(i) Jason is sick because he ate shellfish last night. But Mary did too and *she* didn't get sick.

than in (21b). Further, nothing in our proposal claims that clause order or the recency of the VP antecedent should matter. The prediction that the preferred interpretation of the ellipsis would relate it to the main assertion of the previous sentence, regardless of clause order, was tested in experiment 6, a self-paced reading study.

Experiment 6 also included sentences like those in (22), with two conjoined clauses, only one of which is an appropriate antecedent for the following ellipsis. There is no reason to pick out one of two conjoined clauses as the main assertion of a sentence. Therefore, the main assertion hypothesis makes no prediction about whether (22a) or (22b) would be easier to comprehend. However, in this case, unlike (21), recency is predicted to have an effect. As we discussed in section 2.1, the processing domain provided by a conjoined structure may be either the entire conjoined structure, including all its conjuncts, or just the most recent conjunct. This conjunction domain hypothesis leads us to expect that (22a), where the most recent conjunct is inappropriate as an antecedent for the following ellipsis, will be harder to process than (22b), where the recent conjunct is the appropriate antecedent.

- (22) a. Mary laughed and she was looking mischievous. / Then Tina did too.  
 b. Mary was looking mischievous and she laughed. / Then Tina did too.

### 3.3.1 *Method*

3.3.1.1 *Materials.* Sixteen two-sentence discourses were constructed, with four versions of each. The first sentence of two versions (21a,b) contained a main clause and a subordinate clause. In the (a)-form, the main clause occurred first; in the (b)-form it occurred second. The matrix verb of the (a)-form occurred as the subordinate verb in the (b)-form by moving the subordinate conjunction (*after*) from the beginning of clause two in the (a)-form to the beginning of the sentence in the (b)-form. Two forms (22a,b) were conjoined clauses with the appropriate antecedent VP, the matrix VP of (21a,b), in the first clause (22a) or the second clause (22b). The other conjunct of the (22a,b) forms was inappropriate as the antecedent of *did*. Typically, it was the copular verb (*be*) plus an adjectival phrase. All initial sentences were followed by the same VP-ellipsis sentence. Materials appear in Appendix F.

These 16 discourses were assigned to four counterbalanced lists, with four instances of each version of the initial sentence in each list. Each was followed by a two-choice question (e.g., *What happened? Tina laughed. Tina made a joke.*) as illustrated in Appendix F. An additional 104 sentences and two-sentence discourses of various constructions appeared in each list. The same practice list described in experiment 5 was used in experiment 6.

3.3.1.2 *Subjects and procedures.* Forty-eight University of Massachusetts undergraduates were tested in individual half-hour sessions. The procedures were the same as used in experiment 5. In experiment 6, each of the two

sentences was presented as a single presentation region in the noncumulative fashion described in experiment 5.

### 3.3.2 Results

The mean reading times for the two sentences and question-answering times, and the proportion of matrix answer choices (versions a and b) and appropriate answer choices (versions c and d) appear in Table 5. As in experiment 5, the time measures were less informative than the choice measures. For the sentences containing a main clause and a subordinate clause (21a,b), clause order did not influence reading times, question-answering times, or the frequency of choice of matrix-VP antecedent (all values of  $t$  comparing versions (21a) and (21b) were  $<1.0$ ). Roughly 70% matrix-VP antecedents were chosen, significantly greater than 50% ( $t_1(47) = 8.47, p < .001$ ). Assuming the absence of other factors that might influence choice of antecedent, this value is in line with the predictions of the main assertion tendency. However, the principal conclusion we wish to draw from this part of experiment 6 is that the apparent matrix-antecedent preference does not reflect an underlying preference for primacy or recency of mention.

The conjoined sentences (22a,b) appeared to be read faster numerically when the antecedent VP occurred in the closer conjunct than when it appeared in the distant conjunct, but the difference was not significant ( $t_1(47) = 1.30, p = .20; t_2(15) < 1$ ). Question-answering times did not differ ( $t < 1$ ). However, participants were significantly more accurate when the antecedent VP was in the closer conjunct than when it was in the distant conjunct ( $t_1(47) = 3.29, p < .002; t_2(15) = 2.67, p < .02$ ).

### 3.3.3 Discussion

As predicted by the conjunction domain hypothesis, order did matter for conjunction (22a,b): antecedent VPs in closer conjuncts were processed more accurately (and nonsignificantly faster) than VPs in the distant conjunct. But clause order did not matter for clauses that structurally distinguish the constituent clauses (21a,b) with one expressing the main assertion. In these cases, a majority of matrix VP antecedents was chosen independent of clause order.

Table 5. Mean reading times and question-answering times (ms) and proportions of matrix answers (conditions A and B) and appropriate answers (conditions C and D), experiment 6

Condition	Time		Measure	
	Region 1	Region 2	Question time	Proportion high attachment
A (matrix-subordinate)	2,828	1,267	3,321	.737 matrix
B (subordinate-matrix)	2,802	1,288	3,425	.697 matrix
C (conjoined, initial appropriate)	2,834	1,352	3,216	.777 appropriate
D (conjoined, final appropriate)	2,797	1,268	3,261	.886 appropriate

We would like to suggest that this contrast between main/subordinate and conjoined structure is important. In cases where there is a clear main assertion (21a,b), the antecedent of the VP-ellipsis can be found in discourse structure.<sup>9</sup> Information structure, not order, matters here. But when there is no clear main assertion, the VP-ellipsis antecedent tends to be found in the syntactic representation, where order does matter.

### 3.4 *Experiment 7a*

The results of experiment 6 confirm the expectation that the matrix clause expresses the main assertion in sentences with a subordinate clause. Experiments 4 and 5 suggest that in a matrix clause–complement clause sentence, the matrix clause expresses the main assertion. But is that always so? We expect not. For example, with the complement to a perception verb, it may well be the complement that expresses the main assertion. And, with some matrix clauses (*I think*), the contribution of the matrix clause is “epistemic” and only expresses the speaker’s certainty or degree of commitment to his assertion. In such cases, the clause could often be replaced with an adverb (*presumably, clearly, etc.*).

If the main assertion tendency holds not because the matrix predicate is high in the syntactic tree but because of its information value, then the tendency for a matrix-VP antecedent should not be as strong with (potentially) epistemic matrix clauses as with other (nonepistemic) matrix clauses. Experiment 7a (self-paced reading) tested this prediction.

#### 3.4.1 *Method*

Sixteen two-sentence discourses like (23) were constructed, with four versions of each.

- (23) a. I think Mary smokes. / Sam does too.  
 b. The teacher thinks Mary smokes. / Sam does too.  
 c. I think that Mary smokes. / Sam does too.  
 d. The teacher thinks that Mary smokes. / Sam does too.

In the (a) and (c) forms, a first-person subject of a propositional attitude verb appeared, along with a sentential complement. A second sentence contained VP-ellipsis that in principle could take either the matrix or embedded VP as its antecedent. The (b) and (d) forms were identical except that the matrix subject was a (third person) definite description. The (c) and (d) forms contained the overt complementizer *that*, but otherwise were identical to the (a) and (b) forms, respectively. (Complementizer presence/absence was

<sup>9</sup> Our analysis of the information structure of sentences with main and subordinate clauses is likely to be too simplistic. Some sentences with main and subordinate clauses may express, as their main assertion, precisely the connection between clauses.

manipulated because it was not clear to us which form provided the fairest test of the epistemic phrase/main assertion hypothesis.) All items appear in Appendix G.

These 16 discourses were tested in four counterbalanced lists containing 94 items in all. Each item was presented in two segments, marked by the slash in (23). Experiment 7 was run concurrently with experiment 3, so all the procedures described there apply to the current study.

### 3.4.2 Results

The results of the study appear in Table 6. Reading times longer than 6,000 ms or shorter than 100 ms for one presentation segment were eliminated (1.4% of all responses). No differences in reading times for the second presentation segment (the ellipsis) were significant ( $F < 1$  for the effect of presence vs. absence of *that*,  $F_1(1,47) = 2.474$ ,  $p = .12$ ;  $F_2(1,15) = 1.72$ ,  $p = .21$ , for the epistemic/nonepistemic contrast;  $F_1(1,47) = 1.82$ ,  $p = .18$ ;  $F_2(1,15) = 1.04$ ,  $p = .33$ , for the interaction). Question-answering times did not differ significantly either ( $F_s < 1$  except for the interaction, where  $F_1(1,47) = 3.82$ ,  $p < .06$ ;  $F_2(1,15) = 2.22$ ,  $p < .16$ ).

However, as predicted, matrix-antecedent answers were chosen more frequently for the sentences with third-person subjects (23b,d) than for sentences with potential epistemic clauses or first-person subjects (23a,c) (50% vs. 32%;  $F_1(1,47) = 17.05$ ,  $p < .001$ ;  $F_2(1,15) = 9.23$ ,  $p < .01$ ). All other effects were nonsignificant ( $F < 1$ ).

### 3.5 Experiment 7b

To ensure that the results of experiment 7a obtained for the predicted reason—the availability of a potential epistemic interpretation of the matrix clause—and not due to the person manipulation per se, a follow-up

Table 6. Mean reading times and question-answering times (ms) and proportions of matrix answers, experiments 7a and 7b

Condition	Measure			Proportion high attachment
	Time		Question time	
	Region 1	Region 2		
Experiment 7a				
A (epistemic)	1,819	1,319	2,944	.322
B (nonepistemic)	2,360	1,336	2,734	.508
C (epistemic, <i>that</i> )	1,851	1,242	2,830	.322
D (nonepistemic, <i>that</i> )	2,505	1,358	2,989	.493
Experiment 7b				
A (first person)	2,454	1,249	2,715	.408
B (non-first person)	2,988	1,398	2,862	.402

study, experiment 7b, was conducted. Sixteen two-sentence mini-discourses were constructed with a first-person subject and a third-person subject version of each, as illustrated in (24). The sentences were adapted from those used in experiment 7a primarily by altering the matrix verb. Instead of matrix verbs like *think* or *believe*, which support an epistemic interpretation, the matrix verb was a verb of saying or a verb like *learn* or *find out*.

### 3.5.1 *Methods*

Two versions of each of 16 sentences, like those illustrated in (24), were constructed by modifying the experiment 7a items. All items are included in Appendix H. One version of each of these 16 sentences was included in each of two counterbalanced lists, together with 80 additional sentences of varying structures.

- (24) a. I revealed that Angela spoke Swahili. / Joe did too.  
b. The assistant revealed that Angela spoke Swahili. / Joe did too.

Because the materials did not support an epistemic interpretation in neither the first- nor third-person forms, no difference between the two forms was expected in terms of proportion of choosing matrix antecedents for the elided verb phrase in the second sentence.

Forty-eight University of Massachusetts undergraduates read these sentences in a self-paced reading task, using the procedures described in experiment 7a.

### 3.5.2 *Results*

Table 6 presents the data for experiment 7b. The only data of real interest are the proportions of choice of matrix-antecedent answers, in the rightmost column. These values clearly do not differ, which shows that the effects observed in experiment 7a were due to the epistemic status of the sentences in that experiment, not the use of the first-person pronoun.

## 3.6 *Discussion: Salience Relations*

Four studies supported the main assertion hypothesis. They suggested that readers are more likely to relate new material to material in the matrix clause than to material in a complement clause across sentences than within sentences. However, we have argued that this tendency should be modeled in information-structure terms, not tree-geometry terms, because the informational contribution of a clause matters. As we have shown in experiment 7a, potentially epistemic matrix clauses provide less tempting antecedents than nonepistemic clauses. We have also shown that the order of clauses does

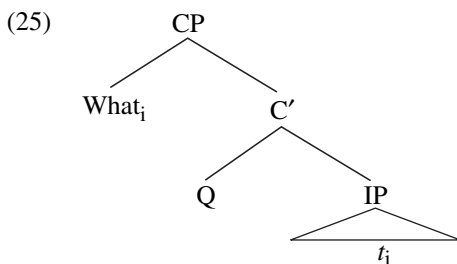
influence processing of antecedents in conjoined clauses but not in main-subordinate clauses.<sup>10</sup>

Our evidence suggests that across sentences, one loses the low attachment or recency preference and instead tends to prefer relating new material to the main assertion of the prior utterance. Thus, we have evidence supporting two systems: a syntactic system based on a syntactic vocabulary with salient recent material, and a discourse system based on discourse entities, information structure, main assertion, and the like, with salience for information occurring in positions where important information is expected to occur.

In section 4 we turn to the processing of sluicing involving islands and the interplay of syntactic and discourse processing.

#### 4. Island Sensitivity

One potential difference in the operations of the syntax and discourse processors is their differing ability to relate material to positions within islands (e.g., violating the Complex NP Constraint). As discussed earlier, sluicing is a structure where an embedded interrogative clause is elided and must be related to earlier material, as illustrated in (25) (see Chung, Ladusaw & McCloskey 1995; also Romero 1998 and Merchant 2001, 2005).



Sluicing is possible either with an overt “inner antecedent” as in (26) or without one as in (27). The elided material is presented in square brackets in (26) and (27).

<sup>10</sup> Some readers have suggested that perhaps readers prefer to relate new material to the main assertion hypothesis because it is a stylistic preference taught to them in grade school. We acknowledge that educators may well attempt to make their students aware of their otherwise-implicit preferences with the aim of improving writing style. But we doubt very much that our results (or those of Walker, Gough, and Wall 1968) can be explained solely in terms of arbitrary prescriptions. Consider that, to produce our results, an educator would have to teach students that main clauses are really important only when they are in a previous sentence, not the current one (experiments 1 and 2). Further, the educator would have to teach the students that, although the distinction between main and subordinate clauses matters, their sequence does not, while on the other hand, the sequence of conjoined clauses does matter (experiment 6). Finally, the educator would have to teach the students that an epistemic main clause like *I think* does not count but a clause like *The teacher thinks* does (experiment 7a) and that a first-person main clause does count when the verb is changed to make the clause nonepistemic (experiment 7b).

(26) John ate something but I don't know what<sub>i</sub> [John ate t<sub>i</sub>].

↑  
overt inner antecedent

(27) John ate but I don't know what [John ate t<sub>i</sub>].

In examples without an overt inner antecedent, the syntactic processor must simply build (“sprout”) the syntactic structure in the elided clause that includes the variable bound by the interrogative constituent. Sprouting of structure is possible only where it violates no syntactic constraint. Frazier and Clifton (1998a) show that it takes longer to read the final clause of the sentence (*but I don't know what*) when sprouting is required (27) than when it is not (26).

In an eye-movement recording experiment, Frazier and Clifton showed that reading an ambiguous sluicing sentence (28a) takes less time on the final clause (*but nobody knows who*) than an unambiguous counterpart disambiguated to the dispreferred structure (28b) (where a slash indicates an analysis region boundary; total reading times, including rereading time, appear below each analysis region, followed in parentheses by first-pass times; all times are in ms).

(28)	a. Somebody claimed / that the president fired / but nobody knows		
	someone	who.	
	1,136 (953)	2,053 (1593)	1,040 (876)
	b. Somebody claimed / that the president fired / but nobody knows		
	Fred	who.	
	1,162 (953)	2,106 (1578)	1,148 (968)

They argued that readers prefer an analysis where the inner antecedent is overtly focused or it occurs in a position where focused material is likely to occur, as in (28a) on the analysis where the embedded object (*someone*) is the inner antecedent. Independent evidence for this assumption derived from an auditory study with a prominent pitch accent on either the matrix subject or the embedded object. More object-antecedent interpretations were reported with the object accent (72%) than with the subject accent (48%).

Chung, Ladusaw, and McCloskey (1995) observed that sluicing may violate the Complex NP Constraint but only if an overt inner antecedent is present (29a), not if sprouting of structure is required (29b).<sup>11</sup>

<sup>11</sup> In the recent linguistic literature, especially Merchant 2005, in press (but also see Fox & Lasnik 2003), a rather elegant account of island violations and ellipsis has emerged. The idea is that illicit (island-violating) movements leave a marker of ungrammaticality “\*” on the illicit intermediate traces. In sluicing, these marks are deleted by the ellipsis, whereas in VP-ellipsis, where island violations lead to clear ungrammaticality, the highest offending \* remains after the VP is elided.

Given the present approach to island violations in sluicing, the difference between sluicing island violations and VP-ellipsis violations must lie elsewhere. One possibility is that Max-ellipsis (Merchant, in press) is violated in the VP-ellipsis example (i) because the entire clause could have been elided, as in (ii).

- (i) \*They want to hire someone who speaks a Balkan language, but I don't remember which they do.
- (ii) They want to hire someone who speaks a Balkan language, but I don't remember which.

- (29) Complex NP Constraint:
- a. They hired someone (who won something) but I can't remember what.
  - b. #They hired someone (who won) but I can't remember what.

Imagine that the discourse processor can perform an operation replacing an overt constituent with a variable of type *e*. That is, when it has cause to do so (there is a missing variable), the discourse processor may replace a constituent with a variable, and it is particularly likely to do so when the constituent is focused. The sluicing behavior noted above would follow immediately, given the processing system proposed here. Sprouting requires actually building syntactic structure—an operation of the syntactic processor. But the syntactic processor cannot violate islands, so no variable can be sprouted inside an island. However, when an overt constituent, especially a (potentially) focused one, is present, the discourse processor can replace it with a variable. The discourse processor can do this even if the constituent is inside an island because, by hypothesis, the discourse processor is not island sensitive.

#### 4.1 Experiment 8a

Experiment 8a (an acceptability judgment questionnaire) tested the predictions of this account in sluicing sentences containing a Complex NP Constraint or a Subject Condition violation, as illustrated in (30) and (31), respectively.

- (30) a. Frederica listened to some tenor who was singing but she didn't say what.  
 b. Frederica listened to some tenor who was singing something but she didn't say what.  
 c. Frederica listened to some tenor who was singing SOMETHING but she didn't say what.
- (31) a. To win is possible but we don't know what.  
 b. To win something is possible but we don't know what.  
 c. To win SOMETHING is possible but we don't know what.

Note that nonsluicing sentences like these are clearly ungrammatical; (32) violates the Complex NP Constraint, and (33) violates the Subject Condition.

- (32) \**What* will Frederica listen to (some tenor who is singing *t*)?  
 (33) \**What* do we know (to win *t*) is possible?

Inside the ellipsis site of (30), a variable must be postulated inside a (copied) complex noun phrase (*the tenor who was singing vbl*). It is this variable that the interrogative constituent binds. Similarly, in (31), a variable

must be postulated inside the subject (*to win vbl*), and it is this variable that the interrogative constituent must bind. We expect that sentences with an overt inner antecedent will be rated relatively acceptable, especially when that antecedent is focused (presented in capital letters), as in (30c) and (31c). Without an overt inner antecedent ((30a) and (31a)), the sentences should be rated less acceptable because neither the syntactic processor, due to the need to go inside an island, nor the discourse processor, which is unable to build syntactic structure, can produce the variable needed to interpret the interrogative constituent.

#### 4.1.1 *Method*

Twelve sentences like (30) and 12 sentences like (31) were constructed, with three versions of each. All sentences appear in Appendix I. They were mixed with 44 filler sentences, including 16 sluicing sentences involving conjunction (e.g., *Katy won a prize and excelled but Alex didn't say what*) and 12 unquestionably unacceptable sentences (e.g., sentences without a gap site in a relative clause). Three versions of each of the 24 experimental sentences were constructed, with no overt inner antecedent or with an overt inner antecedent in either lowercase or uppercase (which was presumed to impart focus). Three counterbalanced forms of a questionnaire were constructed, with four of each set of items in each version. Each sentence was followed by a 5-point rating scale, with 1 marked “unacceptable” and 5 marked “acceptable.”

Forty-eight University of Massachusetts undergraduates completed the questionnaire for course credit. The participants were explicitly instructed to interpret the capitalized words as accented and emphasized and to provide their intuitive judgment of the acceptability of each sentence after reading in a normal fashion. “Acceptable” was described as applying to a sentence that the participant could easily imagine hearing or saying (even if it were complex), and “unacceptable” as applying to a sentence that the participant would say only by mistake or would not expect a native speaker of English to say.

#### 4.1.2 *Results and discussion*

The mean acceptability ratings appear in Table 7. Analyses of variance indicated that the Complex NP Constraint violation sentences were rated as

*Table 7. Mean acceptability ratings, experiment 8a: 5 = acceptable, 1 = unacceptable*

Inner antecedent	Island type	
	Complex NP	Subject Condition
Missing	3.07	2.53
Lowercase	3.40	3.05
Uppercase	3.75	3.35

more acceptable than the Subject Condition violation sentences ( $F_1(1, 47) = 22.93, p < .001$ ;  $F_2(1, 22) = 12.76, p < .002$ ). Of greater interest, the effect of type of inner antecedent was also highly significant ( $F_1(2, 94) = 23.79, p < .001$ ;  $F_2(2, 4) = 12.29, p < .001$ ). Each of the three inner antecedent means differed significantly ( $p < .01$ ) from each other mean. The interaction between the two variables was nonsignificant ( $F < 1$ ). These results indicate that the presence of an overt inner antecedent, stressed or otherwise, alleviates some of the difficulty of finding an inner antecedent of a sluice inside an island. We suggest that this reduction of processing difficulty reflects the operation of the discourse processor, especially its insensitivity to islands.

A reviewer pointed out that over half of the verbs in experiment 8a seem to take indefinite implicit objects but that several (*win, race, drive, fail*, and arguably *trade* and *eat*) apparently take definite implicit objects. The form of sluicing we used requires an indefinite inner antecedent (see Carlson, Dickey, Frazier & Clifton 2005 for experimental work on the comprehension of definite sluices). The reviewer suggested that the results we report might hold true only for the items with indefinite implicit objects. However, we performed separate analyses on the two sets of items and found that each set separately exhibited the pattern of ratings that we reported for the full set.

#### 4.2 Experiment 8b

The final experiment followed up experiment 8a, using a speeded acceptability judgment task, to determine whether the effects seen in experiment 8a depended on the presence of an island. It examined sluicing sentences like those in (34) and (35). The inner antecedent of the sentences in (34) was inside a relative-clause island, whereas in (35) it was not inside an island. To the extent that the increase in acceptability of the sluicing sentence of experiment 8a that had overt inner antecedents was due to the overt constituent enabling the discourse processor to overcome a syntactic island violation, the benefit conferred by the overt inner antecedent should be smaller for sentences without an island than for sentences with the inner antecedent inside an island.

- (34) a. They hired someone who won but I can't remember what.  
 b. They hired someone who won something but I can't remember what.  
 c. They hired someone who won SOMETHING but I can't remember what.
- (35) a. Someone won but I can't remember what.  
 b. Someone won something but I can't remember what.  
 c. Someone won SOMETHING but I can't remember what.

4.2.1 *Methods*

Thirty sentences like those in (34) and (35) were constructed, six versions each. All sentences appear in Appendix J. They were assigned to six counterbalanced lists, so that five sentences of each version appeared in each list, and each sentence occurred in each version in one list. The resulting 30 items in each list were combined with 106 other sentences of a variety of forms.

Sixty University of Massachusetts undergraduates were tested in individual half-hour sessions. The procedures were essentially the same as those described in experiment 3 except that each experimental sentence was presented in two segments: the initial clause, and the clause containing the sluice. Subjects received instructions about how to classify sentences as acceptable or not, made judgments about sentences in a practice list, and then made judgments about the experimental items and the remaining 106 items in an individually randomized order. Responses and reaction times to the sluiced clause were recorded and analyzed.

4.2.2 *Results*

The mean proportion “acceptable” responses and the mean reaction times of all responses appear in Table 8. As was the case previously, reaction times were uninformative. Although times were slower when sprouting was required than when it was not and were slower when the inner antecedent was in a relative-clause island (all  $p < .001$ ), the interaction between sprouting and island was nonsignificant ( $F < 1$ ).

However, analysis of the proportion of “acceptable” responses did indicate that extraction from an island played a role in the difficulty of sprouting. The numbers of “acceptable” responses differed among the three inner antecedent conditions ( $F_1(2,118) = 39.61, p < .001$ ;  $F_2(2,58) = 66.19, p < .001$ ), being lower when sprouting was required than when it was not. Further, relative-clause islands depressed “acceptable” judgments ( $F_1(1,59) = 21.88, p < .001$ ;  $F_2(1,39) = 7.05, p < .01$ ). Most importantly, the interaction between the two factors approached significance ( $F_1(2,118) = 3.92, p = .02$ ;  $F_2(2,58) = 2.32, p = .11$ ). Given that the difference between lowercase and uppercase was negligible, these two conditions were pooled, and the analyses of variance were rerun. Now the interaction  $F$  values were  $F_1(1,59) = 6.58$ ,

Table 8. Proportion “acceptable” and reaction time (ms), experiment 8b

Inner antecedent	Measure			
	Proportion “acceptable”		Reaction time	
	Complex NP	Main clause	Complex NP	Main clause
Missing	.583	.702	2,351	2,158
Lowercase	.794	.833	2,036	1,938
Uppercase	.805	.863	2,050	1,937

$p < .02$ ;  $F_2(1, 29) = 3.49$ ,  $p = .07$ . The requirement of sprouting inside an island lowered acceptability judgments from 80% to 58%, but sprouting in a main clause lowered acceptability judgments only from 85% to 70%.

We take this as suggestive evidence that sprouting inside an island is particularly costly and that some of its cost can be alleviated by providing an overt inner antecedent. The presence of an overt inner antecedent seems to have less of an effect when sprouting is required in a main clause, where no island is present.

### 4.3 Discussion of Experiments 8a and 8b

The results of experiments 8a and 8b indicate that an overt, explicit inner antecedent helps a sluicing sentence to overcome an island violation, especially if the inner antecedent is focused (at least in the acceptability rating study, experiment 8a). We suggest that having an overt inner antecedent permits the discourse processor to interpret the corresponding elided constituent as a variable. Further, the discourse processor can relate an interrogative constituent to such a variable even within an island, especially if the inner antecedent is focused. As argued earlier, the syntactic processor is required to sprout a missing inner antecedent, but it must obey island constraints and thus cannot sprout an antecedent in our island-violation sentences. The main conclusion to take away from experiment 8 is that the syntactic processor and the discourse processor differ both in their ability to build syntactic structure and in their ability to relate material to positions inside islands. The fact that focus improved the status of the island violation sentences in experiment 8a is really striking: typically, one expects violations to be more severe when the focus directs attention to the ill-formedness of the sentence rather than directing attention away from it.<sup>12</sup>

## 5. Conclusions

For the type of ellipsis discussed here—ellipsis that may cross sentences—we have argued that syntactic structure is present for the elided material through copying or sharing of structure from the antecedent. In addition to linguistic evidence for this assumption, the results of experiments 1–3 support this view and present a challenge to alternative views (see Hardt 1993; Shieber, Pereira & Dalrymple 1999).

<sup>12</sup> A reviewer suggested that perhaps an account of these facts could be based on scope. Assuming that an implicit argument must take narrow scope but that a focused argument may scope outside an island, perhaps a scope-based account could be developed. However, this would seem to predict a sharp contrast between focused antecedents, on the one hand, and implicit and unfocused antecedents, on the other, given the usual assumption that relative clauses are islands for (unfocused) quantifiers. This does not fit well with our data, where unfocused overt antecedents are intermediate, sometimes closer to the focus condition and sometimes closer to the implicit condition.

Across sentence boundaries, readers and listeners expect to relate new material to already given material using information structure, not tree structure. Evidence has been presented that the notion of “main assertion” is critical: new material does not typically relate to information presented as being of subordinate importance. Although the notion of “main assertion” requires further elaboration, typically the main assertion of an utterance is the highest predication: the highest VP in sentences containing a main clause and relative clause; the main clause, not the subordinate clause, given a sentence containing main and subordinate clauses, assuming default intonation. In matrix clause–complement clause sentences, typically the matrix predicate contains the main assertion, though we have presented evidence that epistemic matrix clauses do not. We suspect that the complement of a perception verb may also present the main assertion of an utterance. These observations fit with the present proposal that the notion of “main assertion” does not necessarily get fleshed out in terms of some invariant tree geometry property (highest VP). Intonation, for example, is expected to play a critical role in identifying the main assertion of an utterance.

We have proposed that the syntactic and discourse systems operate on distinct representations, the former defined in terms of familiar syntactic vocabulary (DP, VP, c-command, etc.) and the latter crucially involving a representation of discourse entities and the information-structure status of these entities. That a particular constituent or its discourse representation counterpart can be more accessible than some other constituent in syntax but not in discourse representation (or vice versa) is expected on this view. In this sort of framework, it is not too mysterious that the presence of a sentence boundary may decrease the accessibility of the syntactic representation and increase the accessibility of the discourse representation of material preceding the sentence boundary, which would explain the results of experiments 4 and 5, for example (as well as influencing the probability of bound-variable interpretations, see Frazier & Clifton 2000).

Prior psycholinguistic evidence demonstrates that the syntactic processor obeys islands (especially Traxler & Pickering 1996). If one makes the natural assumption that only the syntactic processor may build syntactic structure, then the otherwise surprising distribution of island violations in sluicing follows immediately: island violations are possible, but only if the discourse processor may identify the variable bound by the interrogative constituent in the sluiced clause. The assumption that the discourse processor may replace a copied overt constituent with a variable leads to a natural account of the sluicing facts reported in experiment 8. To our knowledge, our proposal offers the only explanation to date for the observation that island violations are not permitted in “sprouting” examples.

The proposal we have made in the present paper addresses only one piece of a very complex issue. Our proposal raises many questions and makes

numerous predictions beyond those we have tested to date. But we think it does begin to bridge the gap between syntactic processing and discourse processing.

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## **Appendix A: Materials Used in Experiments 1a and 1b**

All four versions of item 1 as used in experiment 1b are shown, but only version A appears for the remaining items. The slash indicates division into presentation segments.

1.     A. Bob ate his burger and rented something to watch /but he didn't say what.  
       B. Bob rented something to watch and ate his burger /but he didn't say what.  
       C. Bob ate his burger and he rented something to watch /but he didn't say what.  
       D. Bob rented something to watch and he ate his burger /but he didn't say what.
2. Barbara cooked roast beef and baked/but she didn't mention what.
3. Jill drank coffee and typed/but I couldn't see what.
4. Timothy stamped his feet and muttered/but nobody knew what.
5. Brenda sent a postcard and promised something/but Jane didn't know what.
6. Martin went home and called/but it's not clear who.
7. Michael slept and studied/but he didn't tell me what.
8. George worked hard and passed/but I forgot what.
9. Linda got angry and ignored someone/but Sally didn't say who.
10. Katy excelled and won a prize/but Alex didn't say what.

11. Roger stewed and mumbled/but nobody could hear what.
12. Lynne slipped and broke something/but she didn't say what.
13. Ellen made molasses cookies and wrapped something/but we don't know what.
14. Jason raked the lawn and built something/but Kate didn't mention what.
15. Josh got frightened and smashed something/but the neighbors didn't say what.
16. Jessica coughed and took some medicine/but I don't know what.

## **Appendix B: Materials Used in Experiment 2**

All four versions of each sentence are illustrated, separated by a slash.

1. Dulles investigated some man Bill said you did./Dulles investigated some man you did, Bill said./Dulles investigated some man Bill said you knew./Dulles investigated some man you knew, Bill said.
2. Clinton disliked some aide Tom reported Gore did./Clinton disliked some aide Gore did, Tom reported./Clinton disliked some aide Tom reported Gore hired./Clinton disliked some aide Gore hired, Tom reported.
3. Hillary praised some reporter Max claimed Bill did./Hillary praised some reporter Bill did, Max claimed./Hillary praised some reporter Max claimed Bill detected./Hillary praised some reporter Bill detected, Max claimed.
4. The victim picked out some suspect Mary said the witness did./The victim picked out some suspect the witness did, Mary said./The victim picked out some suspect Mary said the witness recognized./The victim picked out some suspect the witness recognized, Mary said.
5. Barbara hated some senator Frank claimed Bush did./Barbara hated some senator Bush did, Frank claimed./Barbara hated some senator Frank claimed Bush supported./Barbara hated some senator Bush supported, Frank claimed.
6. Sharon cornered the same guest that John claimed Fred did./Sharon cornered the same guest that Fred did, John claimed./Sharon cornered the same guest that John claimed Fred pestered./Sharon cornered the same guest that Fred pestered, John claimed.
7. Tanya contested every ruling that May reported the DA did./Tanya contested every ruling that the DA did, Mary reported./Tanya contested every ruling that May reported the DA wrote./Tanya contested every ruling that the DA wrote, May reported.
8. Max berated the same employees that Kathy claimed Tom did./Max berated the same employees that Tom did, Kathy claimed./Max berated the same employees that Kathy claimed Tom criticized./Max berated the same employees that Tom criticized, Kathy claimed.

9. Ernesto invited some foreigner that Kate said Tony did./Ernesto invited some foreigner that Tom did, Kate said./Ernesto invited some foreigner that Kate said Tom met./Ernesto invited some foreigner that Tom met, Kate said.
10. Fritz visited some friend that Iran claimed Janis did./Fritz visited some friend that Janis did, Iran claimed./Fritz visited some friend that Iran claimed Janis knew./Fritz visited some friend that Janis knew, Iran claimed.
11. Pamela criticized some editor that Frank suspected Ann did./Pamela criticized some editor that Ann did, Frank suspected./Pamela criticized some editor that Frank suspected Ana hated./Pamela criticized some editor that Ana hated, Frank suspected.
12. Karen taught some child that Jason thought Sue did./Karen taught some child that Sue did, Jason thought./Karen taught some child that Jason thought Sue helped./Karen taught some child that Sue helped, Jason thought.
13. Laura described the criminal that Lou said Tina did./Laura described the criminal that Tina did, Lou said./Laura described the criminal that Lou said Tina identified./Laura described the criminal that Tina identified, Lou said.
14. Carey adored every singer that Carlos mentioned Gary did./Carey adored every singer that Gary did, Carlos mentioned./Carey adored every singer that Carlos mentioned Gary liked./Carey adored every singer that Gary liked, Carlos mentioned.
15. Gregory hired some contractor that Joe said Ellen did./Gregory hired some contractor that Ellen did, Joe said./Gregory hired some contractor that Joe said Ellen fired./Gregory hired some contractor that Ellen fired, Joe said.
16. Michael entertained some executive that Rita said Joel did./Michael entertained some executive that Joel did, Rita said./Michael entertained some executive that Rita said Joel liked./Michael entertained some executive that Joel liked, Rita said.

### **Appendix C: Materials Used in Experiment 3**

Presentation regions for sluicing sentence are marked by a slash.

1. What lecture was Sally impressed {with^after}?  
Sally was impressed {with^after} some lecture, /but I don't remember what.  
Sally was impressed {with^after} some lecture.
2. What part of the driving test did Ferdinand worry {about^after}?  
Ferdinand worried {about^after} some part of the driving test, but he never told us what.  
Ferdinand worried {about^after} some part of the driving test.

3. What movie did John write his homework assignment {about^after}?  
John wrote his homework assignment {about^after} some movie, /but I don't remember what.  
John wrote his homework assignment {about^after} some movie.
4. What news report did Mary cry because {of^after}?  
Mary cried because {of^after} some news report, /but she didn't say what.  
Mary cried because {of^after} some news report.
5. What offensive remark at the rehearsal did Stan apologize {for^after}?  
Stan apologized {for^after} some offensive remark at the rehearsal, /but I forgot what.  
Stan apologized {for^after} some offensive remark at the rehearsal.
6. What exhibition at the Metropolitan did Robert submit an article {about^after}?  
Rob submitted an article {about^after} some exhibition at the Metropolitan, /but Sally forgot what.  
Rob submitted an article {about^after} some exhibition at the Metropolitan.
7. What misunderstanding with Fred was Sandra upset {about^after}?  
Sandra was upset {about^after} some misunderstanding with Fred, /but nobody knew what.  
Sandra was upset {about^after} some misunderstanding with Fred.
8. What academic award did Karsten gloat {about^after}?  
Karsten gloated {about^after} some academic award, /but Ana couldn't recall what.  
Karsten gloated {about^after} some academic award.
9. What illness did Anna suffer {from^after}?  
Anna suffered {from^after} some illness, /but she didn't tell us what.  
Anna suffered {from^after} some illness.
10. What legal proceedings did Luis resign {from^after}?  
Luis resigned {from^after} some legal proceedings, /but he didn't say precisely what.  
Luis resigned {from^after} some legal proceedings.
11. What new policy change did Alex grumble {at^after}?  
Alex grumbled {at^after} some policy change, /but now I've forgotten what.  
Alex grumbled {at^after} some new policy change.
12. What official announcement did Mark get upset {about^after}?  
Mark got upset {about^after} some official announcement, /but we can't recall what.  
Mark got upset {about^after} some official announcement.
13. What official ceremony did Ewan laugh {at^after}?  
Ewan laughed {at^after} some official ceremony, /but he didn't reveal what.  
Ewan laughed {at^after} some official ceremony.

14. \$What boring performance did Paul sleep {through^after}?  
Paul slept {through^after} some boring performance, /but he didn't say what.  
Paul slept {through^after} some boring performance.
15. \$What mishap did Pat tell funny stories {about^after}?  
Pat told funny stories {about^after} some mishap, /but I don't know exactly what.  
Pat told funny stories {about^after} some mishap.
16. \$What incident at work did Paul resign because {of^after}?  
Paul resigned because {of^after} some incident at work, /but we don't know exactly what.  
Paul resigned because {of^after} some incident at work.
17. What press event did the singer run away {from^before}?  
The singer ran away {from^before} some press event, /but she didn't mention what.  
The singer ran away {from^before} some press event.
18. What strange event did Bella write a letter home {about^after}?  
Bella wrote a letter home {about^after} some strange event, /but I never knew what.  
Bella wrote a letter home {about^after} some strange event.
19. What public event did Kyle talk to his students {about^after}?  
Kyle talked to his students {about^after} some public event, /but I don't recall what.  
Kyle talked to his students {about^after} some public event.
20. What noisy sporting event did Gina try to talk to her boyfriend {at^after}?  
Gina tried to talk to her boyfriend {at^after} some noisy sporting event, but she didn't say what.  
Gina tried to talk to her boyfriend {at^after} some noisy sporting event.
21. What event at the meal did Karen complain {about^after}?  
Karen complained {about^after} some event at the meal, /but Tom didn't say what.  
Karen complained {about^after} some event at the meal.
22. What event did Sam get really nervous {about^before}?  
Sam got really nervous {about^before} some event, /but his wife didn't mention what.  
Sam got really nervous {about^before} some event.
23. \$What competitive event was Lisa training hard {for^before}?  
Lisa was training hard {for^before} some competitive event, /but she didn't tell us exactly what.  
Lisa was training hard {for^before} some competitive event.
24. \$What political event did Trevor write stories {about^after}.  
Trevor wrote stories {about^after} some political event, /but we can't remember what.  
Trevor wrote stories {about^after} some political event.

#### Appendix D: Materials Used in Experiment 4

Item (1) is shown in both one-sentence and two-sentence versions, with the following question. Other items are shown only in the one-sentence version; their questions were formed as shown for item (1).

1. John said Fred went to Europe and Mary did too.  
John said Fred went to Europe. Mary did too.  
*What did Mary do? \_\_\_went to Europe. \_\_\_said Fred went to Europe.*
2. Jason claimed Tom left school and Tina did too.
3. Lynne indicated Marcie signed up for a car mechanics class and Peter did too.
4. Lucy mentioned Kathy got sick and Joe did too.
5. Michael wrote Sam got married and Emily did too.
6. Fred thought Max opened a business and Gloria did too.
7. Melissa assumed Karen got a raise and Ernie did too.
8. Julie said Mary went to the rally and Greg did too.
9. Henry suggested Ian studied all yesterday evening and Maria did too.
10. Roger thought Steve missed class and Barbara did too.
11. Jessica assumed Sharon got an award and William did too.
12. Jenny said Anne bought a Siberian husky and Tom did too.

#### Appendix E: Materials Used in Experiment 5

Item (1) is shown in all four versions, followed by a question. The remaining items are shown in the conjoined-name subject, single-sentence condition, without the question.

1. A. John wondered who went where for their vacation. John said Mary went to Europe and Fred did too.  
B. John wondered who went where for their vacation. John said Mary went to Europe. Fred did too.  
C. John and Fred wondered who went where for their vacation. John said Mary went to Europe and Fred did too.  
D. John and Fred wondered who went where for their vacation. John said Mary went to Europe. Fred did too.  
*What happened?*  
*Fred said Mary went to Europe. Fred went to Europe.*
2. Jason and Tina asked who left school. At one point, Jason claimed Tom left school and Tina did too.
3. Lyn and Tim wondered who signed up for what. Then Lyn remembered Marcie signed up for a shop class and Tim did too.
4. Lucy and Joe asked whether anyone got sick. Later Lucy mentioned Kathy got sick and Joe did too.
5. Michael and Emily wondered who got married. Later Michael wrote Sam got married and Emily did too.

6. Fred and Gloria asked if anyone opened a business. Later Fred thought Max opened a business and Gloria did too.
7. Melissa and Ernie were wondering if anyone got a raise. Later Melissa asserted Karen got a raise and Ernie did too.
8. Julie and Greg asked if anyone went to the rally. Later Julie said Mary went to the rally and Greg did too.
9. Henry and Maria wondered whether anyone studied yesterday. Later Henry suggested Ian studied all evening and Maria did too.
10. Roger and Barbara wondered out loud whether anyone dared to miss class. Later Roger said Steve missed class and Barbara did too.
11. Jessica and William asked if anyone they knew got an award. Later Jessica announced Sharon got an award and William did too.
12. Jenny and Tom wondered if anyone bought a dog. Later Jenny assumed Anne bought a Siberian husky and Tom did too.
13. Pamela and Sally wondered who passed the physics exam. Later Pamela reported Gene passed the physics exam and Sally did too.
14. Gretchen and Sandy wondered if children still get lice at school. Later Gretchen admitted Billy got lice at school and Sandy did too.
15. Robert and John wondered if any of their friends received a fellowship. Later Robert revealed Ferne got a fellowship and John did too.
16. Carson and Jeremy asked if anyone had left for the holidays. Later Carson insisted Paulina left already and Jeremy did too.

## **Appendix F: Materials Used in Experiment 6**

All four versions of sentence (1) are shown, together with both question forms. Only versions A and C of the remaining sentences are shown.

1. A. Mary laughed after she made a joke about the supervisor. Then Tina did too.  
B. After Mary laughed she made a joke about the supervisor. Then Tina did too.  
C. Mary laughed and she was looking mischievous. Then Tina did too.  
D. Mary was looking mischievous and she laughed. Then Tina did too.  
*What happened?*  
*Tina laughed. Tina made a joke.*  
*What happened?*  
*Tina laughed. Tina was looking mischievous.*
2. Sam sat down after he introduced himself. Then Fred did.  
Sam sat down and he was unhappy. Then Fred did.
3. Mark telephoned home after he drove downtown. Then Pete did.  
Mark telephoned home and he was sounding angry. Then Pete did.
4. Melissa bought curtains after she went to the hardware store. Then Lisa did.  
Melissa bought curtains and she was smiling a lot. Then Lisa did.

5. Peter crashed his car after he went on vacation. Then Lou did.  
Peter crashed his car and he was dazed. Then Lou did.
6. Rita planted lilacs after she redesigned the garden. Then Pamela did.  
Rita planted lilacs and she was looking very satisfied. Then Pamela did.
7. Bush announced a program after he visited the Middle East. Then Blair did.  
Bush announced a program and he was hopeful. Then Blair did.
8. The host fixed drinks after he greeted the guests. Then the hostess did.  
The host fixed drinks and he was jovial. Then the hostess did.
9. Patrick checked the ticket after he left the travel agency. Later Lynne did.  
Patrick checked the ticket and he was upset. Later Lynne did.
10. Shawn learned French after he went to Paris. Later Greg did.  
Shawn learned French and he was proud. Later Greg did.
11. Ian got a job after he went to Harvard. Later Max did.  
Ian got a job and he was well-liked. Later Max did.
12. Jessica published a novel after she wrote short stories. Later Patsy did.  
Jessica published a novel and she was optimistic. Later Patsy did.
13. David developed a video game after he quit his job. Later Stan did.  
David developed a video game and he was active in his church. Later Stan did.
14. Caitlin started catering after she came to Amherst. Later her sister did.  
Caitlin started catering and she was a mother. Later her sister did.
15. Katherine became a lawyer after she went to Washington. Later Lea did.  
Katherine became a lawyer and she was modeling. Later Lea did.
16. Lisa studied medicine after she became an oncologist. Later her husband did.  
Lisa studied medicine and she was an oncologist. Later her husband did.

## Appendix G: Materials Used in Experiment 7a

The question is illustrated for item (1).

1. I think / The teacher thinks (that) Mary smokes. Sam does too.  
*What about Sam?*  
*He thinks Mary smokes. He smokes.*
2. I think / The assistant thinks (that) Angela speaks Swahili.<sup>1</sup> Joe does too.
3. I believe / The students believe Stan cooks.<sup>1</sup> John does too.
4. I believe / Ron believes (that) Roger plays the violin.<sup>1</sup> Barbara does too.
5. I know / Rob knows (that) Fred listens to WFCR.<sup>1</sup> Gina does too.
6. I know / The principal knows (that) Jason makes robots.<sup>1</sup> Victor does too.
7. I claim / Ian claims (that) Pam lies.<sup>1</sup> Jessica does too.
8. I claim / The councilor claims (that) Karen excels at languages.<sup>1</sup> Thomas does too.
9. I assume / The secretary assumes (that) Lisa wants to get married.<sup>1</sup> Tina does too.

10. I assume / The supervisor assumes (that) Peggy goes to class. | Sharon does too.
11. I guess / Sue guesses (that) Tim leaves tomorrow. | Fred does too.
12. I guess / Katy guesses (that) Edgar reads poetry. | Richard does too.
13. I think / Lucy thinks (that) Pat writes well. | Charles does too.
14. I guess / Bill guesses (that) Lucinda works hard. | Joe does too.
15. I assume / The lawyer assumes (that) Fritz likes dogs. | Teresa does too.
16. I know / The hostess knows (that) Carey hates vegetables. | Tom does too.

## **Appendix H: Materials Used in Experiment 7b**

Question and alternative answers are shown only for item (1).

1. On the program, I learned/the teacher learned that Mary smoked. | Sam did too.  
*What about Sam?*  
*He learned that Mary smokes. He smoked.*
2. I/The assistant revealed that Angela spoke Swahili. | Joe did too.
3. In this episode, I found out/the waiter found out that Stan cooked. | John did too.
4. I/The singer revealed that Roger played the violin. | Barbara did too.
5. I/The student announced that Fred listened to WFCR. | Gina did too.
6. During the interview, I/the guest let slip that Jason made robots. | Victor did too.
7. I/The boss said that Pam lied. | Jessica did too.
8. I/The teacher wrote that Karen excelled at languages. | Thomas did too.
9. I/The reporter started a rumor that Lisa wanted to get married. | Tina did too.
10. I/The principal found out that Peggy went to class. | Sharon did too.
11. I told/The driver told people that Tim left for vacation. | Fred did too.
12. At the crucial moment, I learned/the editor learned that Edgar read poetry. | Richard did too.
13. I assured/Your brother assured you that Pat wrote well. | Charles did too.
14. I swore/The worker swore to you that Lucinda worked hard. | Joe did too.
15. I/The man happened to learn that Fritz liked dogs. | Teresa did too.
16. At the table, I revealed/the mother revealed that Carey hated vegetables. | Tom did too.

## **Appendix I: Materials Used in Experiment 8a**

*Complex NP Constraint violations*

1. They hired someone who won (something) but I can't remember what.
2. The journalist interviewed someone who raced (something) but I don't know what.
3. Jill noticed some stranger who was eating (something) in the computer room but she didn't say what.

4. The neighbors spotted someone who was hunting (something) but they didn't say what.
5. Charles talked to some kids who were playing (something) but he didn't mention which game.
6. Frederica listened to some tenor who was singing (something) but she didn't say what.
7. Gordon quieted someone who was whispering (something) but he didn't know what.
8. Claudia knows someone who knits (something) constantly but she didn't say what.
9. Tom cursed some guy who was driving (somewhere) dangerously but he didn't say where.
10. Jason recognized some girl who screamed (something) but he couldn't hear what.
11. Melissa comforted some student who failed (something) but she didn't mention what.
12. Teresa admires some lady who bakes (something) but she didn't say what.

#### *Subject Constraint violations*

1. To win (something) is possible but we don't know what.
2. To race (something) is stupid but nobody said what.
3. For every visitor to trade (something) is customary in China but the guide didn't say what.
4. To hunt (something) is possible but the ranger didn't mention what.
5. For girls to play (something) is OK in Brazil but Anna didn't say which sport.
6. To sing (something) at the ceremony is possible but Max didn't say what.
7. To paint (something) would be helpful but nobody told me what.
8. To knit (something) in class is alright but the teacher didn't say what.
9. For foreigners to drive (somewhere) is dangerous but the officials didn't indicate where.
10. To juggle (some things) inside is a bad idea but the instructor didn't say what.
11. To criticize (something) is not polite in this culture but Rex didn't say what.
12. To bake (something) at the campsite is possible but Lucy didn't say what.

#### **Appendix J: Materials Used in Experiment 8b**

Each item occurred in three forms: null, lowercase, and uppercase inner antecedent.

1. They hired someone who won something but I can't remember what.  
Someone won something but I can't remember what.

2. The journalist interviewed someone who raced something but I don't know what.  
Someone raced something but I don't know what.
3. Jill noticed some stranger who was eating something in the computer room but nobody said what.  
Some stranger was eating something in the computer room but nobody said what.
4. The neighbors spotted someone who was hunting something but I never heard what.  
Someone was hunting something but I never heard what.
5. Charles talked to some kids who were playing something but nobody mentioned what.  
Some kids were playing something but nobody mentioned what.
6. Frederica listened to some tenor who was singing something but Anita didn't say what.  
Some tenor was singing something but Anita didn't say what.
7. Gordon quieted someone who was whispering something but I don't know what.  
Someone was whispering something but I don't know what.
8. Claudia knows some neighbor lady who knits something constantly but we never figured out what.  
Some neighbor lady knits something constantly but we never figured out what.
9. Tom cursed some guy who was driving somewhere dangerously but nobody found out where.  
Some guy was driving somewhere dangerously but nobody found out where.
10. Jason recognized some girl who screamed something but nobody could hear what.  
Some girl screamed something but nobody could hear what.
11. Melissa comforted some student who failed something but we don't know what.  
Some student failed something but we don't know what.
12. Teresa admires some church lady who bakes something but we don't recall what.  
Some church lady bakes something but we don't recall what.
13. Fernanda praised the girl who was drawing something but I don't know what.  
The girl was drawing something but I don't know what.
14. Melissa wrote to an official who was investigating something but we can't remember what.  
An official was investigating something but we can't remember what.
15. The workmen complained to a supervisor who was watching something but nobody knew for sure what.  
A supervisor was watching something but nobody knew for sure what.

16. Michael dated a teenage girl who was always investigating something but heaven knows what.  
A teenage girl was always investigating something but heaven knows what.
17. Karl knew a woman who was usually baking something but who knows what.  
A woman was usually baking something but who knows what.
18. Shawn talked about a friend who was spending the summer studying something although I have forgotten what.  
A friend was spending the summer studying something though I have forgotten what.
19. The cameraman mentioned an actor who was snorting something but nobody told us what.  
An actor was snorting something but nobody told us what.
20. The seamstress greeted a girl who was cutting something but we couldn't see what.  
A girl was cutting something but we couldn't see what.
21. The designer introduced me to a man who was measuring something but I didn't notice what.  
A man was measuring something but I didn't notice what.
22. Paula introduced us to a strange man who was eating something but we didn't want to know what.  
A strange man was eating something but we didn't want to know what.
23. Cynthia called a friend who was cleaning something but Anne didn't say what.  
A friend was cleaning something but Anne didn't say what.
24. Kyle noticed a policeman who was writing something but even the reporters didn't find out what.  
A policeman was writing something but even the reporters didn't find out what.
25. Angela put up a friend who was painting something but nobody could say what.  
A friend was painting something but nobody could say what.
26. Sandra worried about a guy who was protesting something but only the arresting officer knows what.  
A guy was protesting something but only the arresting officer knows what.
27. Lillian invited home a guy who was apparently trespassing somewhere but we don't know where.  
A guy was apparently trespassing somewhere but we don't know where.
28. The saxophone player hit the guy who was spilling something all over and we can guess what.  
The guy was spilling something all over and we can guess what.

29. The student watched the teacher who was angrily grading something but the student was afraid to ask what.  
The teacher was angrily grading something but the student was afraid to ask what.
30. Fritz likes the secretary who is always drinking something but we can't find out what.  
The secretary is always drinking something but we can't find out what.