

On-Line Comprehension of VP-Ellipsis: Syntactic Reconstruction and Semantic Influence

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We describe two experiments that explored the on-line processing of coordinated (e.g., The policeman defended himself and the fireman did [e] too, according to someone who was there) and subordinated VP-ellipsis (e.g., The policeman defended himself because the fireman did [e], according to someone who was there). Such constructions have two possible interpretations: The "sloppy" reading is that the fireman defended himself, where himself corefers with the fireman. The "strict" reading is that the fireman defended him, where him corefers with the policeman. In our experiments we examined the strict reading, and found different time courses of processing the coordinated and subordinated structures. In coordination we found immediate reaccess of the nonlocal subject at the gap. In subordinated structures we found the reaccess effect only downstream from the gap. We interpret these patterns as reflecting the automatic nature of gap filling in coordinated ellipsis, but in subordinated ellipsis a causal relation must be computed between the two clauses, "drawing out" reaccess of the filler.

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INTRODUCTION

We describe an on-line examination of a long-distance dependency—VP-ellipsis—that, by its structural and semantic character, allows us to make some important suggestions about the operating characteristics of the sentence processor. The manuscript is organized as follows: First, we summarize some psycholinguistic background dealing with related long-distance dependencies. Second, we briefly summarize the linguistic characteristics of VP-ellipsis. We then describe two on-line experiments that attempted to chart the time-course of processing this construction, and conclude with a discussion of our results and their implications for accounts of sentence processing. To preface our conclusions, we suggest that gap-filling is immediate when it involves a structural operation, but is delayed when additional semantic factors are involved.

Psycholinguistic Background

Consider the following from Swinney, Ford, and Bresnan (1989):

- (1) The cop saw *the boy*, that the crowd at the party [1] accused _____ ;
 [2] of the crime.
 (i.e., “. . . the crowd at the party accused *the boy* of the crime”)

This sentence contains a verb—*accused*—that requires a direct object. But in (1) the direct object NP—*the boy*—has been displaced from its canonical postverb position to a position occurring well before the verb, leaving behind a *trace* (in linguistic terminology) or a *gap* (in psycholinguistic terminology). Swinney and colleagues have found that, when listeners encounter such a gap in a sentence, they appear to reaccess the moved NP to which the gap corefers. So, for example, given sentence (1), listeners reaccess the moved NP *the boy* at the lexically unfilled direct object gap position, position [2]. However, at position [1] no evidence of access of *the boy* is observed (also, at the gap there is no evidence for access of an NP that is not the antecedent, for example, *the crowd*).

Relatedly, consider the following construction that can contain either a reflexive or pronoun, each requiring a referent:

- (2) The boxer told the skier that the doctor for the team would blame himself/him.

Nicol (1988) showed that when the reflexive *himself* was used in the sentence, *doctor* was found to be accessed at the reflexive but when *him* was used, both possible antecedents—*boxer* and *skier*—were found to be accessed at the pronoun. According to Nicol, such a processing pattern reflects

principles of binding theory, which requires that reflexives have clause-mate reference but pronouns cannot.

Given this brief background, consider the following VP-ellipsis construction:

- (3) *The policeman_i defended himself_i and the fireman_i did _____^(?) too, according to someone who was there.*

This construction contains two clauses, *the policeman defended himself*, and *the fireman did too*. The second clause contains a bare auxiliary—*did*—indicating the elision of a verb phrase. On some accounts (see Linguistic Analysis presented below), there is an empty category in the elided VP position that is subject to Government and the Empty Category Principle (see, for example, Chomsky, 1986; Lobeck, 1992).

How do listeners interpret this sentence? That is, what does the elided VP position—or gap—refer to? There are two possibilities:

- (a) The policeman_i defended himself_i and the fireman_j did [defend himself_j]. (i.e., the fireman)
- (b) The policeman_i defended himself_i and the fireman did [defend him_i]. (i.e., the policeman)

Interpretation (a)—called the “sloppy” reading—is that the “fireman defended himself,” where *himself* corefers with *the fireman*. This interpretation is typically not too difficult for listeners to generate off-line and is set by the requirements of Principle A of the binding theory: An anaphor must be locally bound; that is, an anaphor must find a clause-mate antecedent. In this case, the reflexive *himself* is bound by the NP *the fireman*. Interpretation (b)—called the “strict” reading—is that “the fireman defended him” where the pronoun *him* co-refers with *the policeman*—the subject of the initial clause. This interpretation is typically more difficult for listeners to generate off-line and is set by Principle B: A pronoun must be free in its governing category [i.e., the pronoun must not be c-commanded by its clause-mate antecedent, and, indeed, in (b) the pronoun *him* is not c-commanded by its antecedent—the NP *the policeman*]. This “strict-sloppy” ambiguity has been fairly well studied in linguistics but has rarely been studied from the perspective of sentence processing.

So, we were interested in how the parser deals with such a construction *on-line* during sentence comprehension for the following reasons. First, examining this construction extends the range of long-distance dependencies that a theory of parsing will need to explain. This dependency is particularly important and complex since it combines the notion of “empty category” with anaphors. That is, the elided construction not only contains an empty category that needs a syntactic antecedent, but processing such a construc-

tion also involves resolving the content of the anaphor and the ensuing ambiguity. Second, VP-ellipsis offers a way to tease apart the contributions of lexical, structural, and semantic-interpretive processes. Our reasoning will become clearer as we present our evidence and our interpretation of it.

The question we specifically asked was: Do listeners automatically access the *strict reading* in the immediate temporal vicinity of the bare auxiliary by showing reaccess of the subject noun phrase from the first (source) clause? We chose the strict reading as our initial focus because it has been observed that it is often the most difficult interpretation to generate off-line (see, for example, Fiengo & May, 1994; Hestvik, in press). Our initial prediction was that, since native speakers can generate this interpretation and that since it is licensed by the syntax, we might observe evidence of it *on-line*. Also, even though the two clauses in such constructions are conjoined and likely are cohesive at the discourse level (see, for example, Kehler, 1994), we predicted that the subject NP from the first clause would *not* be active *before* the gap was encountered since the structural (binding) relation is only evident at the site of ellipsis. That is, we predicted that the strict reading would be observed initially at the gap only and not before the gap in the second clause. Our predictions were partially based on our linguistic assumptions. Therefore, before we present our experiments we briefly consider more details regarding the linguistic analysis of ellipsis.

Linguistic Analysis

Consider the following example:

(4) Dillon likes apples, and Bill does too.

We assume that the missing VP in the second clause is represented by an empty category, denoted [e] in the surface syntactic representation (Lobeck, 1992):

(5) Dillon likes apples, and Bill does [e] too. (S-structure)

This S-structure representation is input to pronunciation. However, in the syntactic theory that we are assuming, the S-structure representation in (5) is fed into a level of syntactic representation that determines semantic interpretation, commonly referred to as logical form (LF). At LF, the empty VP is replaced with material as a function of a dependency on the VP in the preceding clause:

(6) Dillon likes apples, and Bill does [like apples] too. (LF)

The LF representation in (6), then, is input to interpretational processes and accounts for why the elliptical sentence in (4) is interpreted in the same way

as a similar sentence without ellipsis, such as *Dillon likes apples and Bill likes apples too*. This process of filling in the elided material at LF is often referred to as *syntactic reconstruction*; see Kitagawa (1992) and Fiengo and May (1994) for some recent versions of such a theory.

We now turn to the interaction between ellipsis and anaphoric elements like pronouns and reflexives. As we have assumed, pronouns and reflexives have indices that indicate their interpretation (i.e., the NP to which they are interpreted as identical). Following standard notation, coindexing indicates coreference, (while noncoindexing indicates distinct reference) as illustrated below:

- (7) Dillon_i likes himself_i. (i.e., Dillon likes Dillon)
 (8) Dillon_i likes his_j mother. (i.e., Dillon likes Dillon's mother)

Such coreference relations are relatively straightforward, set by the requirements of the binding theory. But what happens when an empty VP is reconstructed on the basis of an overt VP that contains anaphoric elements? The simplest possibility is that the pronoun gets copied along with the index it carries in the preceding VP—as illustrated below—where (9) is the S-structure and (10) the reconstructed representation:

- (9) Dillon_i likes his_j mother, and Bill does [e]_i too.
 (10) Dillon_i likes his_i mother, and Bill does [like his_i mother]_i too.

The resulting interpretation is that *Dillon likes his own mother*, and that *Bill also likes Dillon's mother*—the strict reading. However, as we have shown earlier, there is another interpretation of (9), namely *Dillon likes his own mother and Bill likes HIS own mother*—the sloppy reading. In the theory we are assuming, this reading comes about as follows: A pronoun, when copied, is allowed to change its index to that of the local subject on the condition that the two binding relations are *parallel* in structure. That is, each pronoun is bound to the subject of its own clause, so the structural position of the antecedent relative to the pronoun is identical in the two clauses (see Fiengo & May, 1994, for a detailed discussion about the nature of this parallelism requirement). Thus, an alternative LF representation of (9) is (11):

- (11) Dillon_i likes his_i mother, and Bill_j does [like his_j mother]_j too.

This representation then yields the sloppy interpretation.

When we turn to reflexives, the sloppy reading is derived in the same way since the index change option used with a pronoun can be exercised with a reflexive as well. To illustrate, consider an example like (12):

- (12) Dillon_i likes himself_i, and Bill does [e]_j too.

The index change reconstruction yields (13), which, when interpreted is equivalent to *Dillon likes Dillon and Bill likes Bill*:

(13) Dillon_i likes himself_i, and Bill_j does [like himself_j] too.

With strict readings, however, the situation gets a bit more complex. A reflexive has the requirement that it must find an antecedent in the minimal clause that contains it (Principle A). To illustrate, in (14) the reflexive can only get its reference from the subject *Bill* and not from the nonlocal subject *Dillon*:

(14) Dillon_i likes his mother, and Bill_j likes himself_j.

Given this constraint on the distribution of reflexives and their antecedents, if an elided VP that is reconstructed on the basis of a VP that contains a reflexive simply copies the preceding VP and the reflexive with its index, an ill-formed representation will result. To illustrate, consider again the VP-ellipsis in (15) reconstructed in this way:

(15) *Dillon_i likes himself_i and Bill_j does [like himself_i] too.

Though the indexation in (15) would correspond to a strict reading, i.e., *Dillon likes Dillon and Bill likes Dillon too*, this representation violates the requirement that reflexives have local antecedents; this representation therefore cannot be the source of this interpretation. Since the strict reading is nevertheless acceptable to many speakers, we assume that a reflexive can alternatively be reconstructed as a *pronoun*; such a process has been called *vehicle change* (Fiengo & May, 1994; see also Kitagawa, 1992.). This means that the ellipsis in (15), if reconstructed with the same index as in the overt VP in the source clause, must be reconstructed as in (16):

(16) Dillon_i likes himself_i and Bill_j does [likes him_i] too.

Vehicle change thus allows the strict reading with reflexives by reconstructing the reflexive that is copied from the first to the second clause as a pronoun, circumventing a Principle A violation. That is, in (16) the pronoun *him* can refer back to the nonlocal subject *Dillon*, unlike the reflexive in (15).

Given this view of the linguistic underpinnings of VP-ellipsis—where the elided VP is represented by an empty category and that the strict reading with reflexives additionally involves vehicle change—we now present two on-line sentence comprehension experiments designed to chart the time course of processing this construction. In the first experiment we examined *coordinated* VP-ellipsis constructions—those that use a conjunction (in the present case, *and*) to connect the two clauses. In the second experiment we examined *subordinated* constructions—those using subordination (in the

present case, *because*) to connect the two clauses. Hestvik (in press) has suggested that the strict reading is facilitated when using subordination relative to coordination; thus we chose to also investigate whether or not such facilitation would have implications for on-line processing while expanding the range of ellipsis constructions that we examined.

EXPERIMENT 1: COORDINATED ELLIPSIS

We used the *cross-modal lexical priming* (CMLP) task. In this procedure subjects are presented with spoken (digitized) sentences while simultaneously performing a strategically placed visual lexical decision. In the present experiment subjects were presented with material like (17):

- (17) Last night there was a fire in a downtown building. One person was injured, and there was some question about whether the policeman or the fireman, who were both present at the scene, were to blame for the injury. The two, who were buddies, were being confronted with the charges. **The policeman defended himself, and the fire [1] man did [2] too, according to someone [3] who was there.**

As we discussed in our introduction, there is an elided VP in the target clause of the last sentence of (17). Lexical decision probes were presented either at this position [2], at a “pregap” position [1], or at a “postgap” position [3]. The probes were either semantically related to the potential strict reading antecedent (for example, *robber*, related to *the policeman*), were unrelated (e.g., *roller*), or were orthographically legal nonwords. We predicted that if the nonlocal subject was *reaccessed* at the elided VP position, then semantic priming (faster response times (RTs) to probes related to the antecedent relative to control probes) should be observed at position [2] but not at position [1]. Position [3] allowed us to test if this potential activation of the nonlocal subject continued or dissipated over the temporal course of the sentence. We note that the sentential material presented before the critical sentences was chosen to be neutral; that is, the contexts were set so that it would be relatively likely that either the strict or sloppy reading would be available to the listener.

Method

Subjects. Sixty college students, drawn from a general subject pool, participated in Experiment 1. Twenty subjects each were randomly assigned to the three probe positions.

Materials. Each of ten VP-ellipsis constructions were inserted as the last sentence in a set of spoken paragraphs [as in (17) above]. An additional 20 sentences were constructed as fillers. Some of these sentences contained ellipsis, some did not, but all contained two coordinated or subordinated clauses. Each sentence was matched to a pair of lexical decision probes. The members of each pair were controlled for frequency of occurrence, number of letters and syllables, and base reaction times [using an independent sample of 15 subjects, the mean base RT to the set of related probes was 587 ms; the mean RT to the control probes was 593 ms, $t(14) = .47$].

Procedure

All sentences were recorded and digitized onto a single channel. Tones (inaudible to the subjects during stimulus presentation) were inserted on a second channel. The tones were positioned so that they triggered the presentation of the visual lexical decision probes at one of the three test positions. Probes were also presented at selected points in the filler sentences (before, at, or after the second VP) to lessen any expectations on the part of the listeners.

Each test sentence was heard twice by each subject, once matched with a test probe and once matched with a control probe. Each subject participated in two sessions, with the sessions presented at least 1 week apart. Within each session, half of the sentences was presented with test probes and the other half with control probes. To ensure that the subjects were attending to the sentences, presentation was stopped for 20% of the trials; subjects were required to paraphrase the sentences that they had just heard. During the presentation of each sentence a lexical decision probe appeared on a computer monitor. Subjects responded by pressing one of two response keys labeled *WORD* and *NONWORD*. Reaction times to the lexical decision were recorded.

Results

A mixed-design analysis of variance (ANOVA) was run on the correct RT data averaged across the subjects, with probe position (pregap, VP gap, postgap) as a between-subjects factor and probe type (control, related) as a within-subjects factor. RTs to related probes (846 ms) were significantly faster than to control probes (901 ms), $F(1, 57) = 16.08$, $p < .001$. We also observed an interaction between probe position and probe type, $F(2, 57) = 3.11$, $p = .05$. Protected t -tests revealed a significant difference for the control (954 ms) and related (854 ms) probes presented at the VP gap position, $p < .01$, and between the control (838 ms) and related (788 ms) probes presented at the postgap position, $p < .05$. The mean RT data (in

milliseconds) used in these analyses are shown in (18) below, with an example sentence and the three probe positions:

| | | | |
|------|---------|-----|-----|
| (18) | ROBBER: | 895 | 854 |
| | ROLLER: | 911 | 954 |

The policeman defended himself and the fire [1] man did [2] too, according
 788
 838
 to someone [3] who was there.

Discussion

The data show that at position [1]—the pregap position—significant differences between the related and control probes were not observed. Yet at position [2]—the elided VP position—there were significant RT differences between the related and control probes; the related probes were reacted to faster than the unrelated control probes. These results indicate that, indeed, the nonlocal subject noun phrase—on which the strict reading is based—was reaccessed at the elided position. We note that this pattern is not simply indicative of activation of the subject from the first clause *continuing* across the second clause since there was no priming effect observed at position [1]. Thus, though the strict reading is fairly difficult to generate off-line, there are strong indications of on-line availability of that interpretation *at the point where it is licensed by the syntax*. Such a result also suggests a certain ‘‘processing reality’’ to the notion of vehicle change, since the anaphor that was reconstructed from the first clause and was changed from a reflexive to a pronoun indeed found its *nonlocal* antecedent on-line. Finally, at the downstream postgap position RTs to the related probes were still faster than to control probes (though less so than at the gap position), suggesting that, once reaccessed, the strict reading remained relatively active across the temporal course of the sentence. We will reserve further interpretation of these data until after we present our next experiment.

EXPERIMENT 2: SUBORDINATED ELLIPSIS

In this experiment we tested the *subordinated* VP-ellipsis construction, where the two clauses were connected by *because*. For example, consider.

- (19) The policeman defended himself because the fire[1]man did[2],
 according to someone [3] who was there.

Again, Hestvik (in press) has pointed out that the strict reading is considerably easier to generate off-line in the context of subordinated, relative to

coordinated, ellipsis (see also Kehler, 1993). We therefore predicted that we should observe the same results here as we did with coordinated ellipsis. We presented sentences like (19)—with the same neutral contexts from the first experiment—to an independent group of 60 normal listeners along with the CMLP task. The filler materials and design were the same as those for Experiment 1.

Results

A mixed-design ANOVA was run on the correct RT data, with probe position (pregap, VP gap, postgap) as a between-subjects factor and probe type (control, related) as a within-subjects factor. RTs to related probes (832 ms) was significantly faster than to control probes (859 ms), $F(1, 57) = 4.18$, $p < .05$. Unlike what was observed in Experiment 1 with coordinated ellipsis, the interaction between probe position and probe type was not observed. However, because of what we observed in Experiment 1, we performed a series of protected, paired *t*-tests at each probe position. Only at the postgap position did we observe a significant difference between the related probes (822 ms) and their controls (876 ms), $t(19) = 2.38$, $p < .05$. The data used in these analyses are shown in (20) below:

| | | | |
|------|--------|-----|-----|
| (20) | ROBBER | 859 | 815 |
| | ROLLER | 871 | 829 |

The policeman defended himself because the fire [1] man did [2], according
 822
 876
 to someone [3] who was there.

GENERAL DISCUSSION

The pattern of RT's in Experiment 2 examining subordinated ellipsis was unlike what we found for the coordinated constructions in Experiment 1. That is, in subordinated constructions reaccess of the strict reading was *not* observed at the elided position yet differences between the control and related probes were observed downstream at the postgap position. Recall that in the coordinated construction conditions reaccess was observed immediately at the gap position, and residual activation was observed downstream.

Why did we find distinct patterns of activation in the two types of ellipsis? We take our cue from some of the work of Kehler (1993, 1994), who has pointed out that, unlike coordinated ellipsis, in subordination a *causal* relation between the first and second clause is involved. That is,

something happened—described in the first, source, clause—*just because something happened*—described in the second, target, clause. Thus to locally interpret the target clause, the causal relation between the two clauses must also be computed.⁴ We suggest that computing such a relation takes time and effort—extending the time course of activation of the strict reading in subordinated constructions. In effect, then, we are suggesting that, when the strict reading reflects *syntactic* reconstruction only (as well as vehicle change), reaccess effects are observed immediately at the elided VP position, as is the case in coordinated ellipsis.⁵ But when additional *semantic* factors are involved in the process of strict interpretation—as is the case in subordinated ellipsis—the time course is “drawn out” relative to the time course of activation in the coordinated cases, yielding later-occurring initial effects in subordinated ellipsis.

However, an important issue remains: At what point during the computation of elided constructions does subordination delay gap-filling? Because the evidence suggests that gap filling is typically automatic and

⁴ The situation is much more complex than we have described here. For example, Dalrymple (1991) claimed that elliptical constructions are not syntactically reconstructed, but, instead, interpretation stems directly from a semantic representation. On the other hand, Kehler (1994) claimed that discourse inference interacts with syntactic and semantic representations to yield interpretation of elliptical constructions. And Fiengo and May (1994) and Hestvik (in press) offered strictly syntactic accounts involving the level of logical form. Our work is relatively neutral on these accounts, though it suggests that syntactic reconstruction is likely given that we found immediate gap-filling effects in coordinated structures for the strict reading.

⁵ Fiengo and May (1994) claimed that the strict reading should only be available for reflexives when they occur as the objects of verbs that impose no existential requirement on their objects. Barss has pointed out to us that 7 of our 10 verbs fall into this category (*write*, *buy*, and *slash* do not; see appendix). An initial item analysis of our RT patterns did not show such a distinction, however, though further work would need to be done with a larger set of verbs controlled for such a factor before any strong conclusions could be drawn.

⁶ Recently, McKoon and Ratcliff (1994; McKoon, Ratcliff, & Ward, 1994) have questioned the interpretation of reaccess effects using cross-modal lexical priming. To put it briefly, they claim that these effects reflect the integration of the probes into ongoing sentence analysis; that is, it is the fit of the visually presented lexical decision probes to the spoken sentence that yield apparent reaccess effects, and not the syntactic nature of gap filling. Though it is not within the scope of this paper to dissect this argument (see the reply in Nicol, Fodor, & Swinney, 1994), we point out that in the present experiments the same probes were used at all probe positions and in both the coordinated and subordinated constructions. We found effects at the gap and downstream in the coordinated cases, yet only downstream in the subordinated cases. Consider that the coordinated/subordinated sentences were virtually the same except for one word (*and* vs. *because*); thus it would be quite unlikely that in one case the probes interacted with the sentence and in the other they did not. Our results, therefore, question the generality of the McKoon and Ratcliff explanation.

immediate, computing the causal relation between the two clauses likely does not occur subsequent to this operation since we should have observed immediate gap-filling effects at the elided position. Thus, the delay must occur *prior* to computing the anaphoric relation, perhaps upon immediately encountering the subordinating item. If this is indeed the case, then there is a further prediction: Any construction involving a subordinating relation between two clauses—even nonelliptical ones—should show some delay in computing the relation. For example, given the sentence *The policeman got a sandwich because he was hungry*, we should not observe immediate reaccess of *policeman* at the anaphor in the second clause, but perhaps observe the binding relation downstream. Indeed, even in constructions that do not contain anaphors, some work by T. Bever (personal communication) suggests that subordination delays reconstruction of the memory trace between the two clauses, relative to coordination.

These results and our interpretation of them, we think, have important implications for accounts of first-pass parsing, and indeed have some support from the gap-filling literature in general.⁶ To put it briefly, Swinney and Osterhout (1991) have claimed that immediate gap filling is “perceptual” in the sense that immediate effects are driven by what is licensed by the syntax. Such perceptual gap filling fits with the syntactic nature of the coordinated ellipsis constructions that we have described here. However, there are other types of coreference phenomena that, in Swinney and Osterhout’s terminology, are more “cognitive,” inferences that are predictive, metaphorical, or *causal* in nature; these fit with the subordinated ellipsis constructions. These so-called cognitive inferences indeed appear to have a later-developing time course during on-line sentence processing, as Swinney and Osterhout have shown.

This distinction sets up some work in progress. If immediate reaccess of a filler is driven initially by structural considerations only, then perhaps this *automatic and reflexive* process initially ignores, for example, the lexical properties (i.e., argument structure) of verbs. It turns out that there is a class of verbs whose lexical properties do not—in principle—allow the strict reading in coordinated ellipsis. As an example, consider:

- (21) (a) The policeman_i perjured himself_i and the fireman_j did _____
 (c) too. (other “reflexive” verbs: *redeemed, sunned, exerted, composed, behaved, busied, kill*, etc.)
- (b) The policeman_i perjured himself_i and the fireman_j did [perjure himself_j]. (i.e., the fireman; sloppy reading)
- (c) *The policeman_i perjured himself_i and the fireman_j did [perjure him_i]. (i.e., the policeman; street reading)

A “policeman can perjure himself,” a “fireman can perjure *himself*,” but a “fireman cannot perjure a policeman.” So, the semantic properties of the verb *block* the strict reading (yet the sloppy reading with the same verb is allowed). Verbs that allow only sloppy reference, that, in fact, block strict reference, have been called *reflexive predicates* (see, for example, Levin, 1995). The question we are now asking is: Given that such verbs block the strict reading, will we—or won’t we—observe a reflection of this in our on-line data?

There are, of course, two possibilities here. First, the lexical properties of the verb might very well constrain which noun phrase should be reaccessed at the elided VP position. That is, perhaps verbs like *perjure* will not allow on-line evidence of the strict reading since such a reading is impossible anyway. Indeed, there is evidence from other types of ambiguities that lexical properties do constrain the first-pass analysis of a sentence; some of our own work has supported this (e.g., Shapiro, Nagel, & Levine 1993; see also Trueswell, Tanenhaus, & Kello, 1993.). And, of course, a general constraint-satisfaction parsing account would predict such a lexical effect (see, for example, MacDonald, Pearlmutter, & Seidenberg, 1994). However, a second possibility would be that lexical properties have nothing to do with the initial act of filling a phonologically null position, that such a process, again, is a structural operation that does not make *initial* reference to lexical-semantic or other information. On this account, it would be only later in the time course that we would observe lexical-semantic information exerting its influence (much like what we have observed in Experiment 2 with subordination). Such a result would be very strong evidence for the automatic, reflexive, and informationally encapsulated nature of gap filling. We are currently running such a study.

Finally, we are also running a series of experiments designed to chart the time course of the *sloppy* reading, as shown in (22):

- (22) The policeman from LaJolla defended himself, and the fireman from Encinitas did too . . .

If we indeed find that both the sloppy and strict readings are constructed on-line in coordinated ellipsis (that is both *the policeman* and *the fireman* are found to be reaccessed at the elided position in the second clause), then we will have direct evidence that a listener constructs multiple structural representations at a single temporal point.

CONCLUSIONS

The VP-ellipsis construction allows us to investigate several important issues that have garnered the attention of psycholinguists for years. First, in

our experiments we have shown that different time courses of activation occur depending on the type of relation between two clauses: In coordination, gap filling appears to be immediate. To our minds this pattern may reflect the automatic syntactic nature of establishing coreference. In subordination, gap filling occurs later during the temporal unfolding of the sentence, suggesting the influence of the causal relation between the two clauses. Second, by manipulating the lexical properties of verbs we may be able to tease apart the contribution of lexical-semantic information from syntactic processing. Third, by examining the time course of both strict and sloppy interpretations, we may be able to secure data that reflect on whether or not structural computations occur in parallel.

APPENDIX: MATERIALS FROM EXPERIMENTS 1 AND 2

1. A mailman and his best friend had little in common except their strange taste in ties. A while ago they were out shopping for the holidays. The mailman bought himself a tie for Christmas and/because his best friend did (too), according to the mailman's wife.
2. At the art college an old professor was giving lessons to a talented young teenage student. The student had to practice portrait drawing using models, as well as self-portraits using a mirror. During yesterday's lesson the old professor painted himself and/because the teenager did (too), according to the teaching assistant.
3. Yesterday, the nomination for president of the American Bar Association was held. There were two nominees: Johnson, a criminal defense attorney, and Smith, the real estate expert. In fact, neither of them were particularly enthusiastic about being nominated. When it came to the actual voting, the criminal defense attorney voted for himself and/because the real estate expert did (too), according to the secretary of the election committee.
4. In group therapy it is customary to talk about oneself as much as it is to talk about the other members of the group. Two women from the same neighborhood, a single mother and an older retired woman, were attending therapy for a few months. On the night it was their turn to talk, the single mother talked about herself and/because the retired woman did (too), according to someone who was there.
5. At the weekly meetings of a Japanese sword fighting class, the samurai teachers and the students often cut themselves as a show of strength. But they are equally likely to cut someone else in a fight. Last night, the samurai was instructing a young teenager from California. During the fight the samurai slashed himself and/because the student did (too), according to some of the spectators.
6. Last night there was a fire in a downtown building. One person was injured, and there was some question about whether the policeman or the fireman, who were both present at the scene, were to blame for the accident. The two, who were buddies, were being confronted with the charges during a hearing. The policeman defended himself and/because the fireman did (too), according to someone who was there.
7. A covert operation in a Latin American country had gone wrong, and two servicemen had been killed. There was a meeting of the National Security Council. Both an army general and an airforce general were there. During the meeting, the army general criticized himself and/because the airforce general did (too), according to someone who was there.

8. Two men live together in an apartment near the beach; a dentist and a real estate agent. They're a couple who've been together for several years. But they have serious problems and have started going to therapy. The dentist often criticizes himself and/because the real estate agent does (too), according to their analyst.
9. A teller at a local bank had just paid out \$10,000 to a customer cashing a check. As the customer was leaving, the teller realized that the check was forged and called out to an armed guard to stop the customer. The guard, however, misunderstood and apprehended the wrong person. The forger got away with the money. After the incident, the teller blamed himself for what happened and/because the armed guard did (too), according to the policeman interviewing them.
10. During the trial of Noriega, the DEA and the State Department had a long meeting. Several investigators from both agencies were there. After the meeting the DEA agent wrote himself a memo and/because a State Department agent did (too), according to one of Noriega's lawyers.

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