Ellipsis sites induce structural priming effects

Ming Xiang, Julian Grove, Jason Merchant

University of Chicago

July 2014

Abstract

Exposure to verb phrase ellipsis in English with double-object or prepositional ditransitive antecedents affects syntactic choices in subsequent sentence production, inducing speakers to favor the production of structures parallel to that to which the ellipsis is anaphoric. This result is readily explanable only if ellipsis sites contain or trigger access to syntactic structure (which causes priming), and is incompatible with nonstructural semantic approaches to ellipsis.

1   Introduction

A fundamental ontological question in linguistics is whether an empirically adequate model of grammar, in particular of syntax, requires elements or structures that correspond to no pronounced or signed signal. A central place to look for data bearing on this is the phenomenon of ellipsis. Previous research addressing this question has been divided in its conclusions, answering either in the affirmative or in the negative (see Merchant 2009 and van Craenenbroeck and Merchant 2013 for recent surveys), largely on the basis of grammatical argumentation. In this study, we present new data from an experimental investigation into ellipsis that supports an affirmative answer to the question: our results, we argue, are compatible only with grammatical analyses of ellipsis that posit syntactic structures at the level of analysis used in computing the well-formedness of elliptical structures. Specifically, we show that ellipsis triggers structural priming effects. Following standard approaches to these effects, which attribute them to the activation of syntactic structures by the parser, we conclude that resolving ellipsis requires accessing syntactic structure. There is, in the phrase of Merchant 2001, syntax in the silence, though we construe this more widely than earlier work has. Theories that posit no access to syntactic structure at the ellipsis site and resolve the absent meaning by purely semantic mechanisms cannot account for the data.
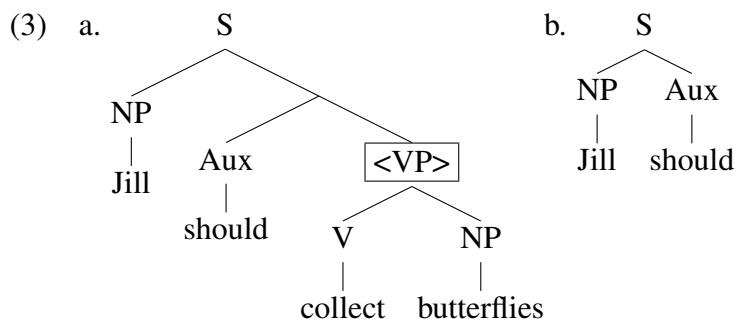
2   Structure in the silence

Much of the literature on ellipsis has been concerned with what Merchant 2009 dubs the *structure* question:

(1)   *Structure question:* In elliptical constructions, is there syntactic structure that is unpronounced?

To put it in concrete terms, the question is whether the missing English verb phrase in (2) should be represented by some kind of unpronounced syntactic material, as in the analysis in (3a), where the boxed VP is not pronounced (representative analyses advocating this view are Chung et al. 1995 and Merchant 2001) or whether the syntax is merely that of a subject NP and an auxiliary modal verb, with no VP node or other inaudibilia involved, as in (3b) (represented by Ginzburg and Sag 2000, Culicover and Jackendoff 2005 and Hardt 1993).[1]

(2)   Bill should collect butterflies. Jill should, too.

(3)   a.

```
                S
              /   \
        NP          \
        |         /    \
        Jill    Aux      <VP>
                 |      /     \
               should  V       NP
                       |       |
                    collect  butterflies
```

   b.

```
        S
      /   \
    NP     Aux
    |       |
   Jill   should
```

The second major question in the study of ellipsis concerns how to generate a meaning for the clauses in which material is missing; Merchant 2009 dubs this the *identity* question, which we reformulate slightly here:

(4)   *Resolution question:* Is understood material in ellipsis resolved by reference to the structure and meaning of its antecedent, or just to the meaning?

In other words, how do speakers plan and listeners recover the meaning of the ellipsis? What are the mechanisms, and what are kinds of linguistic or other representations or processes involved? Different approaches to ellipsis describe this variably as the result of a resolution mechanism, an antecedence relation, an identity constraint, or a parallelism

---

[1]We classify analyses such as Hardt 1993 into the latter group, because although it posits a designated null terminal element *e* to stand in for the missing material, it does not replace this *e* with syntactic structure at any level of representation (unlike LF-copy theories such as Chung et al. 1995 or Lobeck 1995).

constraint (in some cases working together, partially overlapping, and perhaps applying differently in different elliptical constructions). These are all synonymous for our purposes here.[2] Two major (but nonexclusive) options for the identity condition are syntactic and semantic identity: the former defines identity over phrase markers of some sort (Chung et al. 1995, Frazier and Clifton 2001, Sag 1976, and Fiengo and May 1994), and the latter defines identity over semantic representations (Hardt 1993, Dalrymple et al. 1991, Ginzburg and Sag 2000, and Culicover and Jackendoff 2005); hybrid approaches are also possible (Kehler 2002, Chung 2013, Merchant 2013c).

Based on their answers to these two general questions, we classify various approaches to ellipsis resolution into two groups: 'structural' analyses, which include analyses that require syntactic structures at some point in the process of ellipsis resolution (whether this means structures internal to the ellipsis site or recovered under syntactic identity), and 'non-structural' analyses that make reference to syntactic structure neither at any level of representation nor at any point in the resolution algorithm. In this paper we approach the predictions that the various approaches make from the perspective of parsing. We hypothesize that if ellipsis resolution accesses antecedent structure, or if the grammatical computation performed at integration of the ellipsis site requires unpronounced syntactic structure, then the activation of such syntactic structure is likely to lead to observable consequences in downstream processing. On the other hand, nonstructural theories predict that no syntactic activation of the antecedent or of unpronounced local structure should be triggered by an ellipsis site. It is important to note that our goal here is to examine whether syntactic structures are accessed or activated at the ellipsis site, not the narrower question of whether the parser incrementally builds such structures at the ellipsis site: our conclusion that there is syntax in the silence thus includes the possibility that syntax being accessed by the parser during resolution is one way for syntax to be 'in' the silence.

3 Psycholinguistic investigations of ellipsis

Recent years have seen a growing interest in using experimental approaches to probe the kinds of representations that the parser builds at the ellipsis site (see Phillips and Parker 2014 for a critical review). The majority of these studies have been concerned with VP ellipsis in English, which is also the focus of the current study (for experimental studies that include sluicing, see Frazier and Clifton 2005, Yoshida et al. 2012, and Martin and McElree 2011). One group of studies has investigated how information about the antecedent is accessed, in particular whether the complexity of the antecedent, or the distance between the antecedent and the ellipsis site, affects processing at the ellipsis site. Using self-paced

---

[2]While these two questions are often investigated in concert, they are at least partially independent questions: it is possible to analyze ellipsis as involving unpronounced structure which is elliptical by virtue of a contextually recoverable semantic relation (as in the theory of Merchant 2001). Many theories conflate these two questions; there are theories such as Culicover and Jackendoff 2005 that argue for no structure at the ellipsis site and posit a semantic recoverability condition; there are also theories, such as Fiengo and May 1994, which postulate both structures internal to the ellipsis site and a syntactic identity condition.

reading, eye-tracking and speed-accuracy tradeoff techniques, a number of studies (Frazier and Clifton 2001, Martin and McElree 2008, 2009) have shown that there is no additional cost (in terms of reading times or processing speed) at the VP ellipsis site when the antecedent is more complex (e.g., by having a longer antecedent containing a coordination structure vs. a simpler and shorter antecedent), or when more intermediate material is encountered between the antecedent and the ellipsis site (see also Martin and McElree 2011 for very similar results in sluicing). The null effect of antecedent distance/complexity is not observed universally, however, since Murphy 1985, in a sentence-by-sentence reading paradigm, showed that antecedents that are farther away or more complex elicit longer reading times. It therefore seems that we need a more refined theory of anaphoric processing to understand the absence of an antecedent-complexity or distance effect in processing ellipsis. And although examining antecedent complexity or distance is crucial for understanding the exact mechanisms through which the antecedent is accessed, it is actually orthogonal to the question whether the antecedent is syntactic or semantic in nature, since the access mechanism itself is (at least partially) independent from what the antecedents should be. For instance, under the content-addressable pointer mechanism proposed in Martin and McElree 2008, 2011, 2011, the speed to access the antecedent is predicted not to vary with antecedent complexity/distance, regardless of the nature of the antecedent. Similarly, Frazier and Clifton 2001 suggested that copying structures into the ellipsis site is cost-free, entailing that retrieving syntactic representations from a complex and distant antecedent will not necessarily result in slower speeds at the ellipsis site. Since the antecedent complexity/distance manipulation does not make distinct processing predictions regarding whether the parser retrieves a syntactic or semantic antecedent, we are left without a tool that unambiguously distinguishes among the possible answers to the structure and resolution questions (but see Frazier and Clifton 2005 for further discussion).

Cases of VP-ellipsis in which the antecedent clause and the elided clause mismatch in some grammatical feature, such as voice (involving passive antecedents and active ellipsis sites, and vice versa) constitute another empirical domain that has sparked intensive experimental investigations. The earliest research into this domain took the lower acceptability of mismatched antecedent/ellipsis pairs, compared to perfectly matched ones, to suggest that the antecedent and the ellipsis site are constrained by syntactic identity (assuming, for example, that passive and active voices have syntactically distinct structures, but are truth-conditionally equivalent in their argument structure). Some of the earlier experimental results (e.g., Tanenhaus and Carlson, 1990; Mauner et al., 1995) also showed that 'surface anaphors' such as VP ellipsis are more resistant to taking a mismatched antecedent than 'deep anaphors' such as *do it* (but see Murphy 1985 for a different finding), a finding that has a natural explication if there are representational differences between surface and deep anaphors, and if the mechanisms of resolution of these kinds of anaphors make differential use of these representations, as proposed in Hankamer and Sag 1976 and Sag and Hankamer 1984. More recent research, however, has arrived at more nuanced and complex findings. First, there indeed exist fully acceptable mismatches (Hardt 1993, Merchant 2013b), and these would seem to lend support, at least on the surface, to semantic rather

than syntactic identity conditions. But a number of experimental studies (Arregui et al. 2006, Kim et al. 2011) have shown that the gradience in acceptability of mismatched ellipses is compatible with a syntactic identity approach, provided that we take into account the parser's preferences and strategies when executing grammatical operations. Second, the idea that syntactic identity should be evoked to explain unacceptable mismatches has been challenged. In a series of acceptability and self-paced reading studies, Kertz 2013 claimed that an information structure alignment constraint[3] may account for a significant amount of the acceptability penalty of voice mismatch, and concluded that it is information structure, not syntactic identity or discourse coherence conditions, that regulates the identity relation between the antecedent and the elided VP. This proposal fails to account for the entire data set, however: Kertz's own results show that, even once the information structure effect is factored out, there is still an unexplained residual penalty from mismatch found only in ellipsis. This point is also made in SanPietro et al. 2012, who showed that, in contrast to the variability in VP ellipsis, voice mismatch in sluicing is consistently degraded in acceptability and is insensitive to discourse coherence relations (a result found as well by Frazier and Clifton 2006 for VP-ellipsis), suggesting that the semantic identity or discourse/information structure condition alone is not sufficient to explain the mismatch penalty in the broader class of ellipsis phenomena.

Taken as a whole, therefore, the current experimental literature is not conclusive on the question whether abstract syntactic representations are accessed when VP ellipsis is resolved. The current study examines this question again with a different experimental paradigm: syntactic priming.

4   The syntactic priming paradigm

In sentence production, prior recent exposure to certain syntactic structures induces speakers to produce similar structures above a neutral baseline; this reuse of earlier syntactic structures is known as syntactic priming. The classic demonstration of syntactic priming is in Bock 1986; in that experiment, subjects heard and then repeated a prime sentence with a particular syntactic structure containing a ditransitive verb, either a prepositional dative NP PP structure as in (5a) or a double object NP NP structure as in (5b).

(5)   a.   A rock star sold [NP some cocaine] [PP to an undercover agent].
       b.   A rock star sold [NP an undercover agent] [NP some cocaine].

The subjects were then asked to describe a picture that depicted an event that had three participants (and thus was preferentially described with a three-place predicate such as a ditransitive verb) and that was unrelated to the prime sentence (e.g., a picture of a man reading a book to a boy). Bock showed that the structure that people chose to describe the picture was heavily influenced by the structure they had been exposed to in the prime

---

[3]The information alignment constraint is that discourse topics must be sentence topics. This constraint, while conceptually plausible, suffers from the problem that 'sentence topic' is left undefined in Kertz's work.

sentence: more NP PP structures were produced after NP PP primes, and vice versa for NP NP primes. This tendency to repeat previously used structures is not just an artifact of laboratory settings, but has also been consistently observed in spontaneous speech (see Gries 2005 for a corpus study). In addition to production, syntactic priming is also commonly found in comprehension studies (see Tooley and Traxler 2010 for a review).

In principle, priming effects may arise from a number of different sources. A prepositional dative prime and a double object prime differ syntactically; one has an NP NP structure while the other has an NP PP structure, and this could be the main driving force of the priming effect. But at the same time, these two structures also differ in other dimensions, which may have contributed to the observed priming effect. For instance, the thematic roles are mapped onto the surface word order in different ways: the NP denoting the theme precedes the NP denoting the recipient in (5a), but the order is reversed in (5b). It is also possible that the two structures encode slightly different thematic information for the theme and the recipient, which may in turn be the source of the priming effect (e.g., the two NPs may induce slightly different lexical subentailments in the sense of Dowty 1991). Bock and Loebell 1990 and Bock 1989, 1990, however, strongly suggested that it is the syntactic form, rather than the semantics, that the syntactic priming paradigm is sensitive to. These studies showed that locatives such as *The wealthy widow drove her Mercedes to the church* have the same priming effect as a true prepositional dative sentence such as *The wealthy widow gave her Mercedes to the church.* Sentences of both types increase the rate of subsequent productions of prepositional dative structures (such as *The girl is handing a paintbrush to the boy*). Different priming prepositions had similar effects as well: *A cheerleader offered a seat to her friend* and *A cheerleader saved a seat for her friend* both primed *to*-dative PP use to the same degree. Most strikingly, a locative prepositional *by*-phrase such as that found in *The construction worker was digging by the bulldozer* and a *by*-phrase in passives such as *The construction worker was hit by the bulldozer* were both found to prime the production of passives. Taken together, these results strongly suggest that the surface constituent structure of a priming sentence, rather than merely its semantic representation, affects the syntactic encoding of a subsequent sentence. On the other hand, when the constituent structure is different, such priming effects disappear. For example, even though *Susan brought a book to Stella* primes a prepositional dative sentence, the otherwise surface similar *Susan brought a book to study* (where *to study* is either an infinitival relative or a purpose adjunct) does not. We note that the claim that semantic representations never affect syntactic priming may be too strong. Bock et al. 1992 showed that some semantic features, such as animacy, have a priming effect to a certain extent (e.g., speakers were more likely to produce a sentence with an animate subject when they were exposed to an animate subject earlier), but crucially such semantic effects do not alter priming effects based on constituent structure.[4]

As for the specific mechanism behind syntactic priming, following Pickering and Branigan 1998, we will assume that the syntactic planning stage of production makes use of a particular level of lexical representation called the 'lemma stratum' (Levelt et al. 1999).

---

[4]See also Bresnan et al. 2007 for a study of the various factors that influence the choice of dative alternant.

Different kinds of syntactic information are stored in the lemma stratum, including category information (N, V, etc.), featural information (number, gender, etc.), and combinatorial information (subcategorization frames or selectional features). Combinatorial nodes such as NP PP or NP NP are both associated with a verb like 'give' in a speaker's lexicon. If the speaker produces the sentence *The girl gave the boy a flower*, the association between the verb *give* and the combinatorial nodes NP NP will be stronger than usual. The stronger activation of one particular set of combinatorial nodes makes one syntactic structure more accessible over alternative forms for later production, leading to a syntactic priming effect. Pickering and Branigan 1998 further assume that combinatorial nodes are shared by different lemmata (e.g., *give* and *send*), which therefore assures that syntactic priming does not require lexical overlap between the prime and the target (at least for production). In a similar vein (although with important differences), syntactic priming has also been discussed in terms of an implicit learning mechanism that probabilistically updates the mapping between representations at the message/conceptual level to particular structural configurations (Bock and Griffin 2000, Fine and Jaeger 2013) or an active alignment at the lexical and syntactic level between interlocutors in a communicative setting (Pickering and Garrod 2004; and see also Ferreira and Bock 2006 for a review of different proposals).

The consensus that the main source of syntactic priming lies in syntactic representations makes it a suitable tool to study the representations involved in ellipsis resolution. If syntactic structures are activated at the ellipsis site, we would expect such structures to prime future utterances in ways similar to how such structures induce priming when the structures occur in non-elliptical sentences. This paradigm has been applied to elliptical sentences only once in the previous literature to our knowledge. Cai et al. 2013 examined putative ellipsis in Mandarin Chinese after the word *xiang* 'want, like', which can occur with a VP complement or without one; they did not find a priming effect with this verb, and concluded that no syntactic representations were activated after *xiang*. But it is not clear whether a missing complement after *xiang* must be analyzed as involving ellipsis in the first place. No linguistic diagnostics were run to determine whether in fact *xiang* licenses VP ellipsis at all; it is equally as likely that *xiang* is a null-complement anaphora predicate (see Tanenhaus and Carlson 1990, Depiante 2001) as that it licenses any actual ellipsis of its complement: like null-complement anaphors, but unlike ellipses, the understood complement of *xiang* cannot be extracted out of in all contexts, and *xiang* without a complement is easily used without a linguistic antecedent (see Merchant 2013a for discussion of these and other tests). The question therefore remains open whether it is possible to find any syntactic priming effect triggered by a putative ellipsis site. We take on this task in the current study by examining the effect of priming in the well-studied English VP ellipsis constructions.

5 Priming in ellipsis

5.1 Stimuli and Design

Eighteen items were constructed, each with six conditions. Each item consisted of a bi-clausal sentence, and its two clauses were coordinated with the word 'then' or the words 'and then'. An example item is given in Table 1 (the complete list of items is given in the appendix). Two factors were manipulated to create the six conditions. The first factor was the type of prime, with two variants: prepositional dative (NP PP) or double object (NP NP). The first clause of each item in conditions (a) through (c) contained a prepositional dative structure, while a double-object structure appeared in conditions (d) through (f). The second factor was the clause type, with three possibilities: either the second clause of each item contained a VP ellipsis structure (conditions (a) and (d)); it contained a full prepositional dative or double-object structure using the same verb as in the first clause (conditions (b) and (e)); or it contained a simple intransitive predicate (conditions (c) and (f)). All items were constructed to describe a single coherent scenario.

Each of the items was paired with a picture that could plausibly be described with a ditransitive (i.e., prepositional dative or double-object) verb. The content of the picture was unrelated to its associated prime sentence, and this picture was constant across all six of the conditions for a given item.

The full set of items was divided into six lists so that each item appeared once per list in one of its six conditions and so that an equal number of items for each condition appeared in each list. Item-condition pairs were counterbalanced across lists in a Latin square design.

	Clause 1	
Clause 2	*Prepositional Dative (NP PP)*	*Double Object (NP NP)*
	First Ralph sang a song to Sheila, and then	First Ralph sang Sheila a song, and then
Nonelliptical	a. Marcus sang one to her.	d. Marcus sang her one.
Ellipsis	b. Marcus did.	e. Marcus did.
Neutral control	c. Marcus groaned.	f. Marcus groaned.

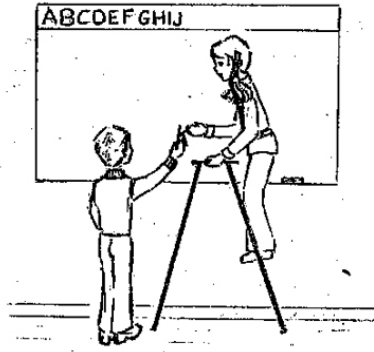**Table 1:** An example of the priming sentence stimuli

Figure 1: An example target picture. Participants were instructed to describe the picture after the priming sentence.

In addition to the 18 experimental items, each of the six lists contained 38 fillers, each consisting of a bi-clausal sentence, but none of these sentences contained ditransitive verbs. Half of the filler sentences contained monotransitive verbs in their active or passive forms, and the other half contained intransitive verbs. Each filler item was paired with a picture that could plausibly be described by a monotransitive verb or an intransitive verb, depending on the type of prime. Each subject, therefore, finished a total of 56 trials.

6 Experiment

6.1 Participants

Eighty-four self-identified native English speakers participated in the study. All participants were recruited from either the undergraduate body at the University of Chicago or from the greater Chicago area. All participants were between the ages of 18 and 35 years old. Participants received either $10 per hour or course credit for their participation.

6.2 Stimulus Presentation and Data Collection

Participants sat isolated in a quiet room with a keyboard and a headset containing headphones. They were told that they would be presented with a sentence on the screen, which they should read silently to themselves, followed by the same sentence presented auditorily through the headphones, after which they would need to repeat the sentence and then describe a picture appearing on the screen. Each trial in the experiment began with a crosshair, and participants were asked to press the space bar on the keyboard in order to initiate the visual presentation of the sentence. The sentence was displayed on the monitor for 5000 ms, after which a blank screen appeared and the same sentence was spoken to participants through the headphones. After the sentence was presented in both modalities, an instruction on the screen reading "Please, repeat." appeared, and subjects repeated the sentence they had just read and heard. After they finished repeating, they pressed the space bar to advance

to the next screen, which presented a picture. They were then instructed to describe orally the event depicted in the picture in a single sentence, and their utterance was recorded. After their description, they pressed the space bar to begin the next trial. All fifty-six items were presented to participants in a random order, with a different randomization for each participant.

Before beginning the experiment, each participant completed ten practice trials while a researcher watched. Practice trials had the same procedure as the experimental trials and contained bi-clausal sentences in which each clause contained an intransitive predicate, different from any of the intransitive predicates used in the experimental session.

6.3   Data transcription and coding

Among the 84 subjects tested, one turned out to be a non-native English speaker, and two did not perform the task correctly. For the rest of the subjects, a total of 1458 tokens were produced (81 subjects x 18 critical trials each). These sentences were coded for the structure of the target construction—that is, whether the speaker produced an NP NP structure (e.g., "A girl is passing a boy a ball") or an NP PP structure (e.g., "A girl passed something to someone who was reaching out to catch it"). Four undergraduate research assistants, all native speakers of American English, did the transcription and coding. An utterance was also coded as a target construction if it utilized an embedded or nominal structure that contained the target construction (e.g., "I think that / it looks like a girl is passing a boy a ball" or "This is a picture of someone passing something to someone else") or if it was preceded by a full sentence or independent clause (e.g., "There's a girl playing catch with a boy, and she's passing a ball to him"). Data of this type constitute less than 3% of the total data. About 33% of the data were classified as belonging to neither of the target constructions (e.g., "A boy and a girl are playing catch" or "A girl is throwing a ball for a boy to catch"). About 67% of the data (975 tokens total) were coded as target constructions under these criteria, and were used for the data analysis reported below.

6.4   Results

Participants made use of a small set of ditransitive verbs to describe the picture stimuli. Table 2 lists all the verbs produced and their frequencies (out of the 975 tokens).

Verb	Frequency	Verb	Frequency
hand	385	pass	18
give	256	sell	4
read	126	display	2
offer	65	deliver	1
show	53	demonstrate	1
serve	22	hold	1
bring	20	lend	1
present	19	tell	1

Table 2: Verb frequencies based on a total of 975 target tokens produced by the participants

Table 3 gives the frequency of each of the two target structures (NP NP and NP PP) produced under each condition. The results showed an overall bias for NP PP structures across the board ($\chi^2(5)$=12, $p < 0.05$).

	NP PP Prime			NP NP Prime		
	Non-elliptical	Ellipsis	Neutral	Non-elliptical	Ellipsis	Neutral
NP PP	108	121	110	98	98	105
NP NP	51	43	56	72	63	50

Table 3: Productions of each target structure under each condition

Figure 2 presents our results, plotting for each of the six conditions the proportion of productions of NP PP structures to productions of NP NP structures. There is an overall bias for NP PP productions regardless of which kind of priming sentence the speakers were exposed to (NP PP productions were above 50% in all conditions). But there is a clear interaction between the structure type of the second clause (non-elliptical, elliptical, or neutral) and the type of the priming sentence: when the second clause of the NP PP priming sentence was non-elliptical, or when it was an elliptical structure anaphoric to the first clause, there was an increase of NP PP productions (10% and 12% respectively, as measured relative to such productions after the NP NP primes), but such a priming effect was absent when the second clause was the neutral control, a simple intransitive.
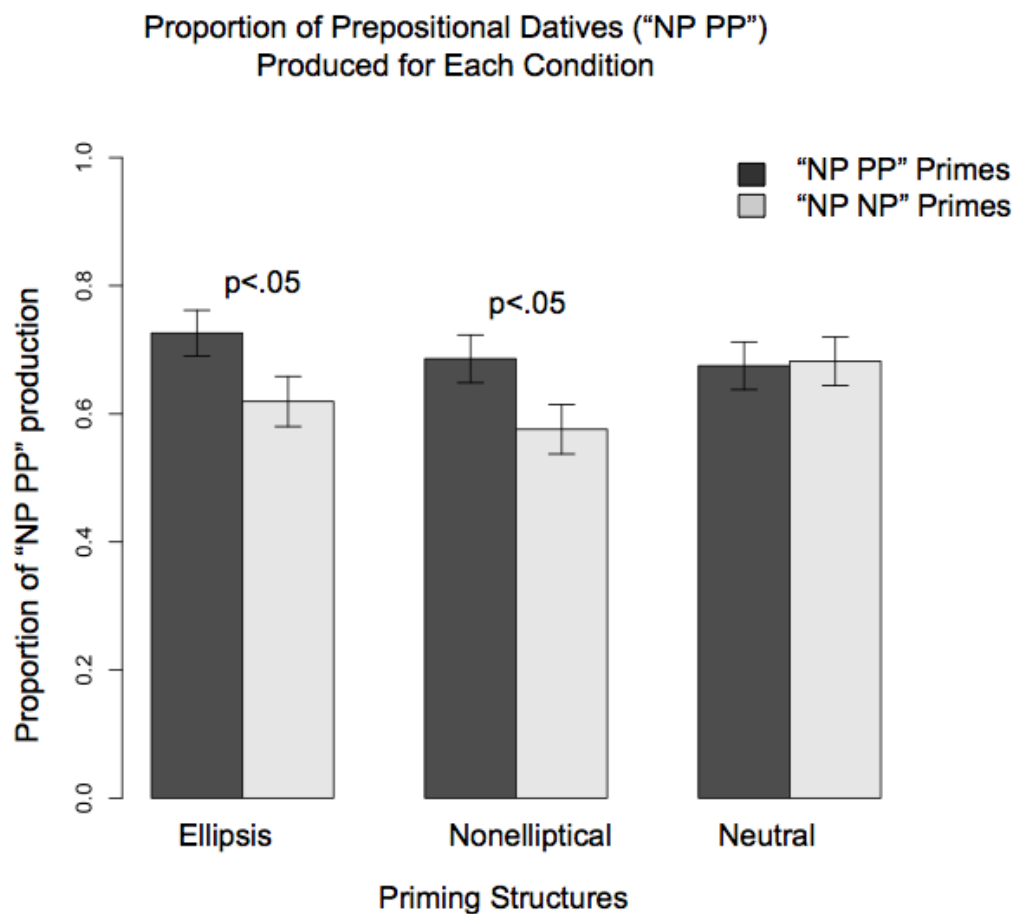
Proportion of Prepositional Datives ("NP PP")
Produced for Each Condition

Figure 2: The y-axis depicts the proportion of NP PP productions (i.e., for each clause structure type under each prime sentence type, the sum of all NP PP productions are divided by the total number of target productions). Error bars indicate standard errors.

For statistical analysis, we carried out a mixed effects logistic model using the lme4 package in R. Mixed effects models take into account sources of variation from both subjects and items simultaneously in the same model. Prior to modeling the data, we coded the NP PP productions as 1, and NP NP productions as 0, such that the dependent variable in our model was the production of an NP PP structure (coding the NP NP production as 1 yielded the same model output). The fixed effects in our model were the type of Prime Structure (2 levels: NP PP or NP NP), the Clause Structure type (3 levels: full non-elliptical structure, ellipsis, and neutral intransitive control), and their interaction. For random effects, we included random intercepts over subjects and items. Adding random slopes into the model did not change the model fit (likelihood ratio test, $ps > 0.9$), and we therefore did not include them in the final model. Next, we used likelihood ratio tests to determine the effect of each fixed effect predictor. The effect of Prime Structure was significant ($p < 0.01$), the effect of Clause Structure type was not ($p > 0.2$), but there was an interaction

between the two (p = 0.05). The significant interaction was due to the fact that the priming effect was modulated by the clause structure type. Planned pair comparisons showed that, under Ellipsis structures, participants produced more NP PP sentences under NP PP primes compared to under NP NP primes ($\beta = 0.73$, se = 0.29, p < 0.05); the same effect held for Nonelliptical structures ($\beta = 0.82$, se = 0.27, p < 0.05); but such a priming effect was absent for Neutral structures ($\beta = -0.08$, se = 0.28, p > 0.8).

7 Discussion

Our results provide strong evidence that syntactic structures are processed at the ellipsis site in VP ellipsis. Repeated exposure in both clauses to a particular syntactic structure increased the likelihood that a speaker would use that structure. This effect is found both in non-elliptical and in elliptical structures. At the same time, the priming effect from the first clause alone seems to be attenuated (or even absent) when the second clause does not contain the relevant structure, but a neutral intransitive clause.[5] These results are consistent with the idea that VP ellipsis sites require the parser to access syntactic structure (either by building it or by retrieving it). Accessing such structure primes the parser, leading to a syntactic priming effect similar to the one found with non-elliptical structures. To the best of our knowledge, this is the first experiment that has found direct evidence for the processing of *syntactic* structures at an ellipsis site.

These results are consistent with a variety of structural theories of ellipsis, whether these involve building of structure (whose pronunciation is omitted due to a semantic or hybrid syntactic+semantic relation to some antecedent, overt or accommodated, as in Merchant 2001, 2013c, and others), the copying of antecedent structure (as in Chung et al. 1995, Frazier and Clifton 2001, and others), or any other implementation that would check or retrieve the syntactic form of the antecedent. Our results, however, are agnostic on deciding between these theories: all of them predict that resolving ellipsis involves the processing (or reprocessing) of syntactic structures. From a parsing perspective, encountering the ellipsis site necessarily initiates a parsing procedure for retrieving an antecedent. Our results show that such retrieval targets syntactic structures.

But our results are not compatible with any theory of ellipsis that posits no complex structure internal to the ellipsis site at any level, and which resolves ellipsis solely using semantic or inferential mechanisms defined over meanings. Such analyses would predict that no syntactic structures need to be accessed in parsing, and therefore would fail to predict the syntactic priming effect we found. One might argue that one possible way to interpret our experimental results consistent with such nonstructural semantic theories is to claim that the semantic differences that have been claimed to exist between the NP

---

[5]Previous results are mixed as to whether syntactic priming effects are short or long-lived. Although Bock and Griffin 2000 found long lasting priming effects when there were multiple neutral clauses intervening in between the prime and the target, there is also evidence that priming effects can be quite transient and diminish over even just one intervening neutral clause (Branigan et al. 1999, Levelt and Kelter 1982). What causes short or long lasting syntactic priming effects is still an open question.

NP and NP PP alternants in verbs that show this alternation are somehow relevant to the computation of ellipsis identity. There are indeed well-studied distributional differences between the prepositional dative and double object constructions, many of which have to do with broader information packaging conditions on use, relative length of the two NPs, the animacy or definiteness of the NPs, and other factors. Bresnan et al. 2007 claim that whether a predicate will realize its argument structure with a double object or with a prepositional dative depends on an optimality computation over all these factors, but that the underlying semantics is uniform; this claim is in line with a long line of research that posits monosemy for such alternating predicates (see also Larson 1988). On such accounts, the double object/prepositional dative alternations are only syntactic variations of the same semantic meaning.

Other proposals postulate two distinct semantic representations—polysemy—for the two variants, often but not always corresponding to different syntactic structures as well: though differing in significant details, such approaches include Green 1974; Oehrle 1976; Pinker 1989; Goldberg 1995; Pesetsky 1995; Krifka 1999, 2001; Harley 2003; Beck and Johnson 2004. If it is true, as seems likely, that the double object and prepositional dative constructions are also semantically different, one may wonder whether the current results could be driven by semantic priming, instead of syntactic priming per se. If this were so, our argument that the observed priming effect implicates the access of syntactic structures at the ellipsis site would be vitiated. For example, Pinker 1989 adopted two distinct semantic representations for these two constructions: the double object construction means CAUSE NP1 to HAVE NP2, while the dative construction means CAUSE NP2 to GO TO NP1 (see Harley 2003 and Bruening 2010 for significant updates). Under such an analysis, one could hypothesize that when people are exposed to one of these semantic representations, they may be primed to produce a structure that is associated with the same semantic representation. This would mean that, to give rise to the current results in the ellipsis condition, it is sufficient for the parser to only activate the particular semantic representation associated with the syntactic structure of the antecedent.

We think that, although not entirely impossible, this alternative explanation is unlikely to be true for a number of reasons. First, as discussed in the introduction, previous experimental work on syntactic priming has suggested that the paradigm itself is primarily sensitive to the similarity in the surface structure of the phrase markers, not semantic/conceptual representations per se (Bock and Loebell, 1990), as shown by the striking observation that a locative *by*-phrase and a passive *by*-phrase both prime a passive structure to the same degree. Bock et al. 1992 also showed that when the task instruction shifts participants' attention towards remembering the meaning of the prime sentence instead of its form, syntactic priming effects are significantly reduced. Given the nature of the syntactic priming paradigm, even if the double-object vs. prepositional-dative alternation were involved variation in both syntactic form and truth conditional semantic meaning, it is still most likely that the current experimental paradigm primarily probes syntactic representations. Second, it is known that whether the double-object/prepositional-dative variants show semantic differences depends on the lexical semantics of a given verb (Rappaport Hovav and Levin,

14

2008). Some verbs, including the ones we used in the current study, appear to have very similar truth conditional meanings in both the alternating forms. Consider sentences containing the verb *give*: 'Abby gave an apple to Ben' and 'Abby gave Ben an apple' both entail the causation of a possession relation and a change of location of an object—in such an example, it is virtually impossible to construct a scenario that makes one alternant true and the other false. It is therefore reasonable to assume that given the narrow set of stimuli we used, there is a relatively small risk of introducing semantic distinctions between the two variant forms. Finally, we note that more work on cross-linguistic comparison will provide a valuable source of evidence to bear on this question. As mentioned above, a similar syntactic priming paradigm involving Chinese double-object/dative alternations did not find priming effects at the putative ellipsis site (Cai et al. 2013). The difference between Chinese and English seems puzzling if the observed priming effect in the current results is mainly driven by semantic differences between the alternating structures, given that the semantic differences between the two alternating structures are likely to be stable across English and Chinese. But we leave for future work the detailed theoretical and experimental comparison between these two languages.

In conclusion, we have shown that ellipsis resolution is sensitive to syntactic form: either the resolution algorithm directly accesses the syntactic representations of the antecedent clause, or it hypothesizes such structures local to the ellipsis site on the basis of a comparison with the antecedent. These results strongly suggest that syntactic structures have to be factored into the grammatical analysis of ellipsis. Of course, this is not to claim that there are no other kinds of more general constraints, such as discourse coherence and information structure, that could play important roles in modulating the acceptability of ellipsis (and their non-elliptical congeners). Such constraints do exist, and there is no reason to believe that merely containing an ellipsis site relieves a structure from having to satisfy those constraints as well—and there is every reason to believe that those constraint operate identically on structures with and without ellipsis (see Tancredi 1992 for an early statement of this important insight). The division of labor between syntax and discourse constraints is an important question for future linguistic and psycholinguistic research (see Frazier and Clifton 2005, 2006 for some discussion on this issue), but we contend, based on the current results, that any theory of ellipsis resolution that eschews reference to syntactic structure— that is, nonstructural theories in the sense elaborated above—cannot account for these data. Only structural theories of ellipsis are compatible with our findings.

References

Arregui, Ana, Charles Clifton Jr., Lyn Frazier, and Keir Moulton. 2006. Processing elided verb phrases with flawed antecedents: The recycling hypothesis. *Journal of Memory and Language* 55:232–246.

Beck, Sigrid, and Kyle Johnson. 2004. Double object again. *Linguistic Inquiry* 35:97–124.

Bock, Kathryn. 1986. Syntactic persistence in language production. *Cognitive Psychology* 31:163–186.

Bock, Kathryn. 1989. Closed-class immanence in sentence production. *Cognition* 31:163–186.

Bock, Kathryn. 1990. Structure in language: Creating form in talk. *American Psychologist* 45:1221–1236.

Bock, Kathryn, and Zenzi M. Griffin. 2000. The persistence of structural priming: Transient activation or implicit learning? *Journal of Experimental Psychology: General* 129:177–192.

Bock, Kathryn, and Helga Loebell. 1990. Framing sentences. *Cognition* 35:1–39.

Bock, Kathryn, Helga Loebell, and Randal Morey. 1992. From conceptual roles to structural relations: Bridging the syntactic cleft. *Psychological Review* 99:150–171.

Branigan, Holly P., Martin J. Pickering, and Alexandra A. Cleland. 1999. Syntactic priming in written syntactic priming in written production: Evidence for rapid decay. *Psychonomic Bulletin and Review* 6:635–640.

Bresnan, Joan, Anna Cueni, Tatiana Nikitina, and Harald Baayen. 2007. Predicting the dative alternation. In *Cognitive foundations of interpretation*, ed. G. Boume, I. Kraemer, and J. Zwart, 69–94. Amsterdam: Royal Netherlands Academy of Science.

Bruening, Benjamin. 2010. Ditransitive asymmetries and a theory of idiom formation. *Linguistic Inquiry* 41:519–562.

Cai, Zhenguang G., Martin J. Pickering, and Patrick Sturt. 2013. Processing verb-phrase ellipsis in Mandarin Chinese: Evidence against the syntactic account. *Language and Cognitive Processes* 28:810–828.

Chung, Sandra. 2013. Syntactic identity in sluicing: How much, and why. *Linguistic Inquiry* 44:1–39.

Chung, Sandra, William A. Ladusaw, and James McCloskey. 1995. Sluicing and Logical Form. *Natural Language Semantics* 3:239–282.

van Craenenbroeck, Jeroen, and Jason Merchant. 2013. Elliptical phenomena. In *The Cambridge handbook of generative syntax*, ed. Marcel den Dikken, 1427–1520. Cambridge University Press.

Culicover, Peter W., and Ray Jackendoff. 2005. *Simpler Syntax*. Oxford: Oxford University Press.

Dalrymple, Mary, Stuart M. Sheiber, and Fernando C. N. Pereira. 1991. Ellipsis and higher-order unification. *Linguistics and Philosophy* 14:399–452.

Depiante, Marcela A. 2001. Ellipsis in Spanish and the stranded affix filter. In *North East Linguistic Society*, ed. Minjoo Kim and Uri Strauss, 215–224. Georgetown University: GLSA.

Dowty, David. 1991. Thematic proto-roles and argument selection. *Language* 67:547–619.

Ferreira, Victor S., and Kathryn Bock. 2006. The functions of structural priming. *Language and Cognitive Processes* 21:1011–1029.

Fiengo, Robert, and Robert May. 1994. *Indices and identity*. Cambridge, Massachusetts: MIT Press.

Fine, Alex B., and T. F. Jaeger. 2013. Syntactic priming in language comprehension allows linguistic expectations to converge on the statistics of the input. In *Proceedings of the*

35th Annual Meeting of the Cognitive Science Society.

Frazier, Lyn, and Charles Clifton, Jr. 2001. Processing coordinates and ellipsis: Copy α. *Syntax* 8:121–174.

Frazier, Lyn, and Charles Clifton, Jr. 2005. The syntax-discourse divide: Processing ellipsis. *Syntax* 8:121–174.

Frazier, Lyn, and Charles Clifton, Jr. 2006. Ellipsis and discourse coherence. *Linguistics and Philosophy* 29:315–346.

Ginzburg, Jonathan, and Ivan A. Sag. 2000. *Interrogative investigations*. Stanford, Calif.: CSLI Publications.

Goldberg, Adele E. 1995. *Constructions: A construction grammar approach to argument structure*. Chicago: University of Chicago Press.

Green, Georgia M. 1974. *Semantics and syntactic regularity*. Bloomington, Indiana: Indiana University Press.

Gries, Stefan Th. 2005. Syntactic priming: A corpus-based approach. *Journal of Psycholinguistic Research* 34:365–399.

Hankamer, Jorge, and Ivan A. Sag. 1976. Deep and surface anaphora. *Linguistic Inquiry* 7:391–428.

Hardt, Daniel. 1993. Verb phrase ellipsis: Form, meaning and processing. Doctoral Dissertation, University of Pennsylvania.

Harley, Heidi. 2003. Possession and the double object construction. In *Yearbook of Linguistic Variation*, ed. Pierre Pica and Johan Rooryck, volume Yearbook of Linguistic Variation, 29–62. Benjamins.

Kehler, Andrew. 2002. *Coherence in discourse*. Stanford, Calif.: CSLI Publications.

Kertz, Laura. 2013. Verb phrase ellipsis: the view from information structure. *Language* 89:390–428.

Kim, Christina S., Gregory M. Kobele, Jeffrey T. Runner, and John T. Hale. 2011. The acceptability cline in VP ellipsis. *Syntax* 14:318–354.

Krifka, Manfred. 1999. At least some determiners aren't determiners. In *The semantics/pragmatics interface from different points of view*, volume 1 of *Current Research in the Semantics/Pragmatics Interface*, 257–291. Elsevier Science B. V.

Krifka, Manfred. 2001. Quantifying into question acts. *Natural Language Semantics* 9:1–40.

Larson, Richard. 1988. On the double object construction. *Linguistic Inquiry* 19:335–392.

Levelt, William J. M., and Stephanie Kelter. 1982. Surface form and memory in question answering. *Cognitive Psychology* 14:78–106.

Levelt, William J. M., Ardi Roelofs, and Antje S. Meyer. 1999. A theory of lexical access in speech production. *Behavioral and Brain Sciences* 22:1–75.

Lobeck, Anne. 1995. *Ellipsis: Functional heads, licensing and identification*. New York: Oxford University Press.

Martin, Andrea E., and Brian McElree. 2008. A content-addressable pointer mechanism underlies comprehension of verb-phrase ellipsis. *Journal of Memory and Language* 58:879–906.

Martin, Andrea E., and Brian McElree. 2009. Memory operations that support language comprehension: Evidence from verb-phrase ellipsis. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 35:1231–1239.

Martin, Andrea E., and Brian McElree. 2011. Direct-access retrieval during sentence comprehension: Evidence from sluicing. *Journal of Memory and Language* 64:327–343.

Mauner, Gail, Michael K. Tanenhaus, and Greg N. Carlson. 1995. A note on parallelism effects in processing deep and surface verb-phrase anaphors. *Language and Cognitive Processes* 10:1–12.

Merchant, Jason. 2001. *The syntax of silence: Sluicing, islands, and the theory of ellipsis*. Oxford: Oxford University Press.

Merchant, Jason. 2009. Ellipsis: A survey of analytical approaches. To appear in Jeroen van Craenenbroeck and Tanja Temmerman (eds.), The Oxford Handbook of Ellipsis.

Merchant, Jason. 2013a. Diagnosing ellipsis. In *Diagnosing syntax*, ed. Lisa Lai-Shen Cheng and Norbert Corver, 537–542. Oxford: Oxford University Press.

Merchant, Jason. 2013b. Polarity items under ellipsis. In *Diagnosing syntax*, ed. Lisa Lai-Shen Cheng and Norbert Corver, 441–462. Oxford: Oxford University Press.

Merchant, Jason. 2013c. Voice and ellipsis. *Linguistic Inquiry* 44:77–108.

Murphy, Gregory L. 1985. Psychological explanations of deep and surface anaphora. *Journal of Pragmatics* 9:785–813.

Oehrle, Richard. 1976. The grammatical status of the English dative alternation. Doctoral Dissertation, Massachusetts Institute of Technology.

Pesetsky, David. 1995. *Zero syntax*. Cambridge, Massachusetts: MIT Press.

Phillips, Colin, and Dan Parker. 2014. The psycholinguistics of ellipsis. *Lingua* .

Pickering, Martin J., and Holly P. Branigan. 1998. The representation of verbs: Evidence from syntactic priming in language production. *Journal of Memory and Language* 39:633–651.

Pickering, Martin J., and Simon Garrod. 2004. Toward a mechanistic psychology of dialogue. *Behavioral and Brain Sciences* 27:169–+.

Pinker, Steven. 1989. *Learnability and cognition. the acquisition of argument structure*. Cambridge, Massachusetts: MIT Press.

Rappaport Hovav, Malka, and Beth Levin. 2008. The English dative alternation: The case for verb sensitivity. *Journal of Linguistics* 44:129–167.

Sag, Ivan A. 1976. Deletion and logical form. Doctoral Dissertation, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Sag, Ivan A., and Jorge Hankamer. 1984. Toward a theory of anaphoric processing. *Linguistics and Philosophy* 7:325–345.

SanPietro, Steve, Jason Merchant, and Ming Xiang. 2012. Accounting for voice mismatch in ellipsis. In *Proceedings of the 30th West Coast Conference on Formal Linguistics*, ed. Nathan Arnett and Ryan Bennett, 303–312. Somerville, Mass.: Cascadilla Press.

Tancredi, Christopher. 1992. Deletion, deaccenting and presupposition. Doctoral Dissertation, Massachusetts Institute of Technology, Cambridge.

Tanenhaus, Michael K., and Greg N. Carlson. 1990. Comprehension of deep and surface

verbphrase anaphors. *Language and Cognitive Processes* 5:257–280.

Tooley, Kristen M., and Matthew J. Traxler. 2010. Syntactic priming effects in comprehension: A critical review. *Language and Linguistic Compass* 4:925–937.

Yoshida, Masaya, Michael Walsh Dickey, and Patrick Sturt. 2012. Predictive processing of syntactic structure: Sluicing and ellipsis in real-time sentence processing. *Language and Cognitive Processes* .

Appendix: Materials

1. a. First Ralph sang a song to Sheila, and then Marcus did.
   b. First Ralph sang a song to Sheila, and then Marcus sang one to her.
   c. First Ralph sang a song to Sheila, and then Marcus groaned.
   d. First Ralph sang Sheila a song, and then Marcus did.
   e. First Ralph sang Sheila a song, and then Marcus sang her one.
   f. First Ralph sang Sheila a song, and then Marcus groaned.

2. a. First the Mellon foundation awarded a grant to the professor, and then the National Science Foundation did.
   b. First the Mellon foundation awarded a grant to the professor, and then the National Science Foundation awarded one to her.
   c. First the Mellon foundation awarded a grant to the professor, and then the National Science Foundation followed.
   d. First the Mellon foundation awarded the professor a grant, and then the National Science foundation did.
   e. First the Mellon foundation awarded the professor a grant, and then the National Science foundation awarded her one.
   f. First the Mellon foundation awarded the professor a grant, and then the National Science foundation followed.

3. a. First the victim told the story to the reporter, and then the lawyer did.
   b. First the victim told the story to the reporter, and then the lawyer told it to her.
   c. First the victim told the story to the reporter, and then the lawyer cried.
   d. First the victim told the reporter the story, and then the lawyer did.
   e. First the victim told the reporter the story, and then the lawyer told her the story.
   f. First the victim told the reporter the story, and then the lawyer cried.

4. a. First the head coach handed a cup to the athlete, and then the assistant coach did.
   b. First the head coach handed a cup to the athlete, and then the assistant coach handed one to her.
   c. First the coach handed a cup to the athlete, and then the assistant coach nodded.
   d. First the head coach handed the athlete a cup, and then the assistant coach did.

  e. First the head coach handed the athlete a cup, and then the assistant coach handed her one.

  f. First the head coach handed the athlete a cup, and then the lawyer cried.

5 a. First the college issued an ID card to the residents, and then the state did.

  b. First the college issued an ID card to the residents, and then the state issued one to them.

  c. First the college issued an ID card to the residents, and then the state intervened.

  d. First the college issued the residents an ID card, and then the state did.

  e. First the college issued the residents an ID card, and then the state issued them one.

  f. First the college issued the residents an ID card, and then the state intervened.

6 a. First the bartender served a martini to the underage student, and then the waiter did.

  b. First the bartender served a martini to the underage student, and then the waiter served one to him.

  c. First the bartender served a martini to the underage student, and then the waiter got suspicious.

  d. First the bartender served the underage student a martini, and then the waiter did.

  e. First the bartender served the underage student a martini, and then the waiter served him one.

  f. First the bartender served the underage student a martini, and then the waiter got suspicious.

7 a. First the bank mailed a loan application to the student, and then the college did.

  b. First the bank mailed a loan application to the student, and then the college mailed one to her.

  c. First the bank mailed a loan application to the student, and then the college chipped in.

  d. First the bank mailed the student a loan application, and then the college did.

  e. First the bank mailed the student a loan application, and then the college mailed her one.

  f. First the bank mailed the student a loan application, and then the college chipped in.

8 a. First the couple on the first floor owed a month's rent to the landlord, and then the guy on the second floor did.

  b. First the couple on the first floor owed a month's rent to the landlord, and then the guy on the second floor owed a month's rent to him.

  c. First the couple on the first floor owed a month's rent to the landlord, and then the guy on the second floor moved out.

  d. First the couple on the first floor owed the landlord a month's rent, and then the guy on the second floor did.

e. First the couple on the first floor owed the landlord a month's rent, and then the guy on the second floor owed him a month's rent.

f. First the couple on the first floor owed the landlord a month's rent, and then the guy on the second floor moved out.

9 a. First the father fed a carrot to the 3-year-old boy, and then the mother did.

b. First the father fed a carrot to the 3-year-old boy, and then the mother fed one to him.

c. First the father fed a carrot to the 3-year-old boy, and then the mother laughed.

d. First the father fed the 3-year-old boy a carrot, and then the mother did.

e. First the father fed the 3-year-old boy a carrot, and then the mother fed him one.

f. First the father fed the 3-year-old boy a carrot, and then the mother laughed.

10 a. First the little girl read a short story to the old woman, and then the boy did.

b. First the little girl read a short story to the old woman, and then the boy read one to her.

c. First the little girl read a short story to the old woman, and then the boy was happy.

d. First the little girl read the old woman a short story, and then the boy did.

e. First the little girl read the old woman a short story, and then the boy read her one.

f. First the little girl read the old woman a short story, and then the boy was happy.

11 a. First Ms. Andrews sent a troublemaker to the principal, and then Mr. Lewis did.

b. First Ms. Andrews sent a troublemaker to the principal, and then Mr. Lewis sent one to him.

c. First Ms. Andrews sent a troublemaker to the principal, and then Mr. Lewis was relieved.

d. First Ms. Andrews sent the principal a troublemaker, and then Mr. Lewis did.

e. First Ms. Andrews sent the principal a troublemaker, and then Mr. Lewis sent him one.

f. First Ms. Andrews sent the principal a troublemaker, and then Mr. Lewis was relieved.

12 a. First a rock star sold some cocaine to an undercover agent, then a movie star did.

b. First a rock star sold some cocaine to an undercover agent, then a movie star sold some to one.

c. First a rock star sold some cocaine to an undercover agent, then a movie star died from overdose.

d. First a rock star sold an undercover agent some cocaine, and then a movie star did.

e. First a rock star sold an undercover agent some cocaine, and then a movie star sold one some.

f. First a rock star sold an undercover agent some cocaine, and then a movie star died from overdose.

13 a. First the lifeguard tossed a rope to the swimmer, and then the instructor did.
   b. First the lifeguard tossed a rope to the swimmer, and then the instructor tossed one to her.
   c. First the lifeguard tossed a rope to the swimmer, and then the instructor called for help.
   d. First the lifeguard tossed the swimmer a rope, and then the instructor did.
   e. First the lifeguard tossed the swimmer a rope, and then the instructor tossed her one.
   f. First the lifeguard tossed the swimmer a rope, and then the instructor called for help.

14 a. First the mother promised a puppy to the girl, and then the father did.
   b. First the mother promised a puppy to the girl, and then the father promised one to her.
   c. First the mother promised a puppy to the girl, and then the father smiled.
   d. First the mother promised the girl a puppy, and then the father did.
   e. First the mother promised the girl a puppy, and then the father promised her one.
   f. First the mother promised the girl a puppy, and then the father smiled.

15 a. First the waitress took a tray to the customers, and then the maitre d' did.
   b. First the waitress took a tray to the customers, and then the maitre d' took a tray to them.
   c. First the waitress took a tray to the customers, and then the maitre d' bowed.
   d. First the waitress took the customers a tray, and then the maitre d' did.
   e. First the waitress took the customers a tray, and then the maitre d' took them one.
   f. First the waitress took the customers a tray, and then the maitre d' bowed.

16 a. First Ralph passed a note to Linda, and then Mark did.
   b. First Ralph passed a note to Linda, and then Mark passed one to her.
   c. First Ralph passed a note to Linda, and then Mark got jealous.
   d. First Ralph passed Linda a note, and then Mark did.
   e. First Ralph passed Linda a note, and then Mark passed her one.
   f. First Ralph passed Linda a note, and then Mark got jealous.

17 a. First the foundation gave five million dollars to the university, then the government did.
   b. First the foundation gave five million dollars to the university, then the government gave five million to them.
   c. First the foundation gave five million dollars to the university, then the government investigated.
   d. First the foundation gave the university five million dollars, then the government did.
   e. First the foundation gave the university five million dollars, then the government gave them five million.

f. First the foundation gave the university five million dollars, then the government investigated.

18 a. First the inspector offered a deal to the bar owner, then the cop did.
    b. First the inspector offered a deal to the bar owner, then the cop offered one to him.
    c. First the inspector offered a deal to the bar owner, then the cop showed up.
    d. First the inspector offered the bar owner a deal, then the cop did.
    e. First the inspector offered the bar owner a deal, then the cop offered him one.
    f. First the inspector offered the bar owner a deal, then the cop showed up.