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ScienceDirect

Lingua 151 (2014) 78–95

Lingua

www.elsevier.com/locate/lingua

Review

The psycholinguistics of ellipsis

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Received 13 September 2012; received in revised form 19 September 2013; accepted 4 October 2013
Available online 27 November 2013

Abstract

This article reviews studies that have used experimental methods from psycholinguistics to address questions about the representation of sentences involving ellipsis. Accounts of the structure of ellipsis can be classified based on three choice points in a decision tree. First: does the identity constraint between antecedents and ellipsis sites apply to syntactic or semantic representations? Second: does the ellipsis site contain a phonologically null copy of the structure of the antecedent, or does it contain a pronoun or pointer that lacks internal structure? Third: if there is unpronounced structure at the ellipsis site, does that structure participate in all syntactic processes, or does it behave as if it is genuinely absent at some levels of syntactic representation? Experimental studies on ellipsis have begun to address the first two of these questions, but they are unlikely to provide insights on the third question, since the theoretical contrasts do not clearly map onto timing predictions. Some of the findings that are emerging in studies on ellipsis resemble findings from earlier studies on other syntactic dependencies involving *wh*-movement or anaphora. Care should be taken to avoid drawing conclusions from experiments about ellipsis that are known to be unwarranted in experiments about these other dependencies.

Keywords: Ellipsis; Sentence processing

1. Introduction

Ellipsis is a cover-term for a number of linguistic phenomena where a sentence lacks material that would normally be obligatory, and the missing material is nevertheless semantically recoverable from the local syntactic or semantic context. The term 'ellipsis' derives from the intuition that the missing material has been elided, i.e., it has been deleted from the surface form of the sentence. Some examples from English include VP-ellipsis (1a), NP-ellipsis (1b), and sluicing (1c), a form of clausal ellipsis.

1. a. Chloe wouldn't like to climb a big rock face, but Zoe would.
   b. Marvin really likes Beth's chocolate chip cookies, but he can't stand Judy's.
   c. Teresa is sure that Bob said something nice on her birthday, but she can't remember what.

Ellipsis phenomena are linguistically interesting because a clear interpretation is conveyed despite the absence of overtly expressed material. This leads to questions about how ellipsis is mentally represented and how the interpretation of the elided material is recovered. The search for answers to these questions is helped by the fact that each type of

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0024-3841/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.lingua.2013.10.003

ellipsis is subject to a number of constraints. Recent years have seen a surge of interest in ellipsis phenomena in theoretical linguistics, leading to many new findings about the constraints on individual ellipsis phenomena (for review, see Merchant, in press). There has at the same time been a steadily growing body of experimental work that has begun to explore similar phenomena, and there has been optimism about the possibility that experimental findings might provide answers to questions that to-date have been addressed only using standard acceptability judgment evidence.

Our goal in this paper is to survey the current state-of-the-art in experimental research on ellipsis, and to articulate what it does and does not contribute to theoretical debates about ellipsis.[1] Also, ellipsis is not the first area where linguists have hoped that experimental findings might arbitrate between competing theories. Similar hopes have been expressed in debates about unbounded dependencies (e.g., *wh*-movement, relativization, scrambling) and anaphora. In some cases, such as the dispute over whether *wh*-movement leaves empty categories or 'traces', certain experimental findings were initially regarded as theoretically decisive, and then later seen to be inconclusive. As we shall see, some of the experimental findings on ellipsis may be headed down a similar path. They are being presented as evidence for phonologically null structure, despite the fact that similar arguments about *wh*-movement would not be regarded as decisive evidence for empty categories.

The structure of the article is as follows. Section 2 introduces three key issues on which accounts of the representation of ellipsis differ. Section 3 reviews experimental findings on antecedent-ellipsis mismatches. Section 4 highlights some conclusions from experimental studies on wh-dependencies and anaphora that should be taken seriously when interpreting closely related experiments on ellipsis. Section 5 reviews findings on what properties of the antecedent are accessed at the ellipsis site, and how quickly. Section 6 summarizes findings from studies that have used antecedent-size manipulations as a probe for the representation of structure at the ellipsis site. Section 7 concludes.

2. The representation and derivation of ellipsis

2.1. Three theoretical choice points

Many different types of phenomena are handled under the rubric of ellipsis, including VP-ellipsis (2a), NP-ellipsis (2b), sluicing (2c), and comparatives (2d). Ellipsis in all of these cases involves the omission of some material that is required for full interpretation of the sentence. We follow the common practice of indicating the ellipsis site with an underline, but we do so without intending commitments on the mental representation of ellipsis.

2. a. Juanita left the party early, and Marcel did __ too.
   b. The judge reviewed the plaintiff's testimony and then the defendant's __.
   c. The mayor voted for a presidential candidate, but he didn't say which one __.
   d. The teacher read more books than the students did __.

Ellipsis might appear to be just another piece of linguistic ephemera. However, it has proven to be a model system for studying sound-meaning correspondences. Ellipsis represents a break down in the usual mapping between sound and meaning. As such, analyses of ellipsis have sought to determine how speakers recover an interpretation in the absence of input.

Research in this domain has given rise to several grammatical alternatives, focusing on three aspects of ellipsis resolution. These alternatives can be visualized as a decision tree, as shown in Fig. 1.

2.2. The nature of the antecedent

Ellipsis is anaphoric in nature, as it depends on an antecedent in the context for recovery of meaning. The relationship between the ellipsis and its antecedent is not unconstrained. Rather it is subject to a parallelism requirement, typically stated in terms of a formal identity constraint. This identity constraint may be demonstrated via tests of compatibility with the sentence fragment that introduces the ellipsis. Thus, ellipsis in (3b) is assumed to be parallel at some level to the corresponding nonelliptical sentence in (3a), as indicated by the strikethrough text. Ellipsis is well-formed in (3b) because the antecedent VP *read the book* is syntactically and semantically compatible with the ellipsis clause. In contrast, ellipsis

[1] We are hesitant to use the term 'theoretical' here, as it can leave the misleading impression that traditional process-neutral accounts of language structure count as theories, whereas real-time accounts of mental linguistic computation are not; and it invites the even more misleading conclusion that theoretical linguistics is not an empirical pursuit. But we trust that the reader will avoid these assumptions.

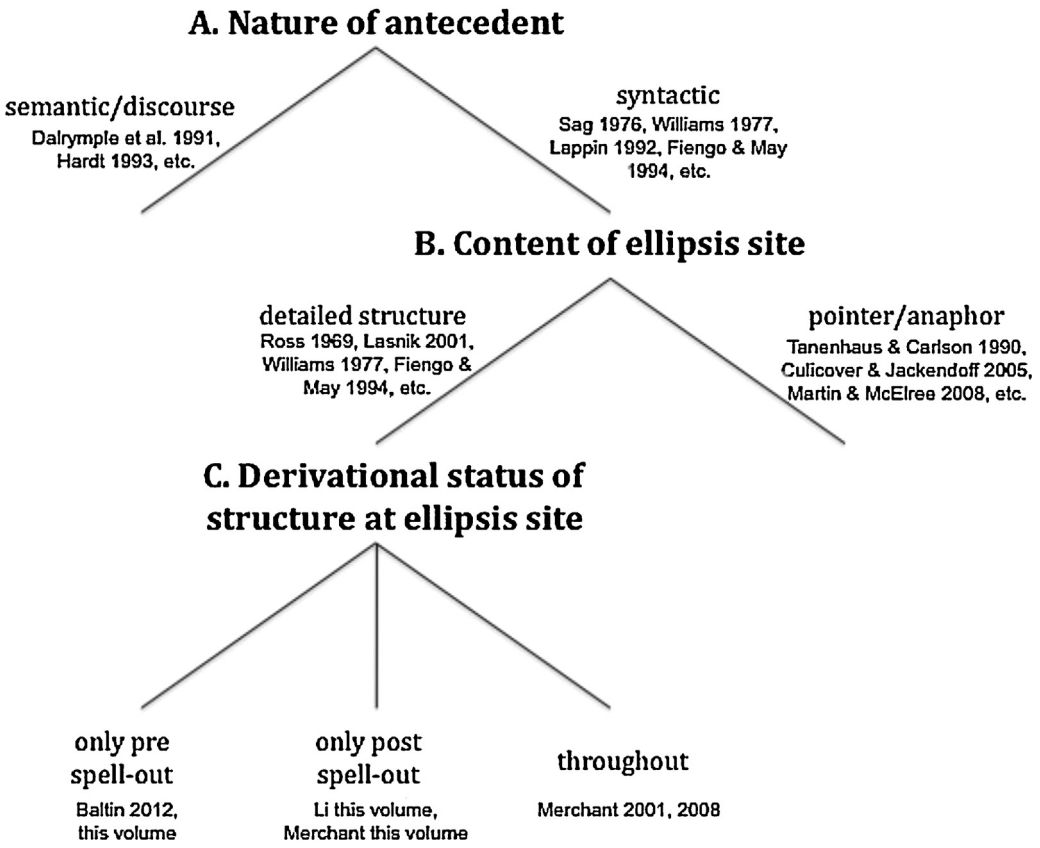

Fig. 1. Grammatical alternatives in theories of ellipsis resolution.

in (3c) is typically treated as ill-formed, because the passive antecedent clause is incompatible with the ellipsis clause, which is in active voice.

3. a. The teacher will read the book, and the students will read the book.
   b. The teacher will read the book, and the students will ~~read the book~~, too.
   c. *The book was read by the teacher, and the students will ~~read the book~~, too.

The nature of the identity constraint and its precise formulation has been extensively debated in linguistics. Much of the debate has focused on the question of whether the identity requirement is defined over syntactic structures, or over semantic representations. From the perspective of sentence comprehension, the correct formulation of the identity constraint is potentially important for understanding what guides the parser in the recovery of an antecedent (see Kim et al., 2011 for related discussion).

There are differing views on what specific representation has to be identical with the ellipsis site. The *syntactic account* claims that the representation of an elided phrase is recovered under some form of structural identity. The *semantic account* claims that the recovery process involves identity of meaning. The syntactic identity condition is generally assumed to not be defined over surface representations. For example, Sag (1976) argued that a surface identity condition was too restrictive. Following observations by Halliday and Hasan (1976) and Quirk et al. (1972), Sag pointed out that ellipsis is acceptable in (4a) despite the mismatch in affix marking. In this example, the auxiliary verb *may* selects for an uninflected verb, but the verb in the antecedent is inflected. Therefore, the identity requirement cannot involve a perfect copy of the surface form of the antecedent.

4. a. Bob entered the competition and Paul may ~~enter the competition~~, too.
   b. *Bob entered the competition and Paul may ~~entered the competition~~, too.

Evidence for a syntactic identity constraint comes from examples of unacceptable voice mismatch, such as (5b) and (6b). The argument for syntactic identity is made here by showing that syntactic incompatibility at the ellipsis site results in

unacceptability (Sag, 1976; Williams, 1977). It is generally assumed that corresponding passive and active forms are semantically equivalent but syntactically different, so if ellipsis is sensitive to the difference between active and passive structures, then this implies a syntactic identity constraint.

5. a. John looked into this problem, and Bill did ~~look into this problem~~ too.
   b. *This problem was looked into by John, and Bill did ~~look into this problem~~ too.

(Kehler, 2000; ex. 34)

6. a. The driver reported the incident, and the pedestrian did too ~~report the incident~~.
   b. *The incident was reported by the driver, and the pedestrian did too ~~report the incident~~.

(Kertz, 2010; ex. 6)

It is well known, however, that a strict syntactic identity condition is too restrictive, in light of the acceptability of voice mismatches in examples like (7–9).

7. This problem was to have been looked into, but obviously nobody did ~~look into this problem~~.

(Kehler, 2000)

8. Of course this theory could be expressed using SDRSs, but for the sake of simplicity we have chosen not to ~~express this theory using SDRSs~~.

(from Lascarides and Asher, 1993, reported in Kehler, 2000)

9. In March, four fireworks manufacturers asked that the decision be reversed, and on Monday the ICC did ~~reverse the decision~~.

(Dalrymple et al., 1991)

The acceptability of ellipsis in (7–9) is consistent with a semantic identity condition, under the assumption that actives and passives are semantically equivalent. Semantic accounts (Dalrymple et al., 1991; Hardt, 1992, 1993, 1999a,b; Kehler, 1993; Ginzburg and Sag, 2000; Merchant, 2001; van Craenenbroeck, 2010) define the identity condition at the level of semantic representation, without restriction on the syntactic form of the antecedent. Further arguments for semantic identity have been based on cases of ellipsis involving scopal interactions and coreferential vs. bound variable interpretations of pronouns. However, Merchant (2013) argues that those phenomena can be handled equally well under a syntactic approach, so the cases of syntactic non-identity, as in (7–9), represent perhaps the best evidence for a semantic identity condition.

Following Dalrymple et al. (1991) the semantic identity condition may be stated over the meanings of predicates. According to this analysis, the elided VP in (10a) corresponds to an uninstantiated relation, denoted by property *P* in (10b). Property *P* is determined by the interpretation of the antecedent clause, and may be instantiated as (10c). Property *P* applied to the antecedent and ellipsis yields parallel interpretations (10d–e).

10. a. The secretary released this information, but Gorbachov didn't ~~release this information~~.
    b. release(*the secretary*, *this information*), but not *P*(*Gorbachov*)
    c. *P* = λ*X.release*(*X, this information*)
    d. *P*(*the secretary*) = release(*the secretary*, *this information*)
    e. *P*(*Gorbachov*) = release(*Gorbachov*, *this information*)

This approach appeals to the semantic representations of predicates to account for the identity condition. As such, voice mismatch ellipsis in (7–9) is predicted to be well-formed because the antecedent clause and ellipsis have identical semantic predicates. For example, both the antecedent and the ellipsis clause in (7) involve identical predicates, as in (11).

11. *P* = λ*X.look-into*(*X, this problem*)

Of course, the challenge for this approach is that it overgenerates, incorrectly predicting acceptability in (5b) and (6b). These apparently conflicting data present a challenge for any attempt to indentify a single level of representation to formalize the licensing condition on ellipsis.

This conflict has motivated a third, hybrid approach that incorporates certain conditions on discourse relations. Kehler (1995, 2000, 2002) argues that the contradictory VP-ellipsis data can be explained by an interaction between ellipsis and the discourse relations that hold between the antecedent and ellipsis clause. Kehler proposes that both syntactic identity and semantic identity guide recovery of an antecedent. Specifically, he argues that the type of discourse relation that holds

between the antecedent and the ellipsis clause determines the level of representation at which ellipsis is resolved (see Frazier and Clifton, 2006 for critical discussion). Kehler argues that when the two clauses stand in a ''resemblance'' relation, syntactic identity is required, predicting degradation in cases of a syntactic mismatch. By contrast, mere propositional identity is sufficient when the antecedent and ellipsis clauses are part of a ''cause–effect'' relation. One cue to the discourse relation between clauses is the form of the clausal conjunction. For example, the relation between the clauses in (5) is most plausibly a resemblance relation, which is compatible with the conjunction *and*, whereas the relation between clauses in (7) signals a cause–effect relation, which is compatible with the conjunction *but*.[2] This analysis yields the correct predictions for (5–10). Ellipsis in (5–6) requires syntactic identity under the resemblance relation, and shows degradation in the cases of voice mismatch. Ellipsis in (7–10) does not require syntactic identity, since the clauses are classified as describing a cause–effect relation, and there appears to be little or no degradation resulting from syntactic mismatch.[3]

Recent findings from acceptability judgment experiments provide some support for the hybrid account. Runner and colleagues have shown that discourse relations influence the acceptability of voice mismatches in ellipsis (Kim et al., 2011). They found that the mismatch effect was reduced, but not completely eliminated, in sentences that support a cause–effect relation (e.g., 7–10). Experimental findings on ellipsis mismatches are discussed further in section 3.

2.3. The content of the ellipsis site.

The next level in the decision tree concerns the content of the ellipsis site. Two positions can be distinguished here, both of which are variants of the syntactic account. The debate here is over whether or not there is unpronounced syntactic structure at the ellipsis site. Most syntactic analyses assume that the ellipsis site hosts a detailed structural representation of the antecedent (*null copy account*). An alternative analysis appeals to the anaphoric nature of ellipsis, and assumes that the ellipsis site does not include a copy of the antecedent (*pointer account*).

In the linguistic literature, the choice between the copy account and the pointer account is sometimes framed as part of a larger debate about the need for unpronounced elements in syntax, and whether it is possible to simplify theories by avoiding such objects (e.g., Culicover and Jackendoff, 2005). However, there is little reason to view one approach as inherently preferable over the other, as the cost of avoiding unpronounced structure is the need for mechanisms that can generate meaning in the absence of structure (cf. Jackendoff, 2002 for useful discussion). In language processing, the null copy account and the pointer account may make divergent predictions about the time-course of ellipsis resolution. Some studies have pursued the reasoning that if syntactic material is present at the ellipsis site, then the syntactic complexity of the elided material should affect the time required to resolve ellipsis. If on the other hand structure is absent, manipulating the syntactic complexity should not affect time-course measures. However, this contrast is not straightforward, as both approaches have ways of capturing effects and non-effects of antecedent complexity. We address this literature in section 6.

One important source of evidence on the representation of the ellipsis site comes from (anti-)connectivity effects. Connectivity refers to situations where a fronted phrase can be interpreted as if it occupied some position lower than its position in the surface form. Connectivity in ellipsis may be tested via compatibility between an overt part of the elided clause and some component of the supposed elided structure. Connectivity effects have been presented as evidence for the presence of structure at the ellipsis site, and anti-connectivity effects as evidence for the absence of structure. Two widely cited examples involve case matching and island effects (for fuller discussion see Merchant, 2013).

Case matching has been offered as an instance of a connectivity effect that motivates a null copy account of ellipsis. In languages with overt case-marking, such as German, the case of the wh-phrase in a sluicing fragment must match the case of the fronted wh-phrase in the nonelliptical counterpart, as illustrated in (12). As originally argued by Ross (1969) and later discussed by Merchant (2001), case matching effects may be explained if an unpronounced case assigner is present in the ellipsis site.

12. a. *Case Matching (German)*

Er	will	jemandem	schmeicheln,	aber	sie	wissen	nicht
he	*wants*	*someone.DAT*	*flatter*	*but*	*they*	*know*	*not*
*wer/		*wen/	wem.				
who.NOM		*who.ACC*	*who.DAT*				

'He wants to flatter someone, but they don't know who'

[2] According to Kehler, the conjunction *but* in (7), (8), and (10) signals a specific type of cause-effect relation that he terms the ''violated expectation'' reading.

[3] Although the antecedent and ellipsis clauses are conjoined by *and* in (9), Kehler argues that the conjunction in this example signals a ''result'' reading, which is a type of cause–effect relation.

b. Er will jemandem schmeicheln, aber sie wissen nicht
he wants someone.DAT flatter but they know not
*wer/ *wen/ wem er schmeichelen will.
who.NOM who.ACC who.DAT he flatter wants
'He wants to flatter someone, but they don't know who he wants to flatter'

Similar to case matching, number agreement is sensitive to the relation between overt and elided material (13).

13. There shouldn't have been any errors in the report, but there were/*was ~~errors in the report~~.

Additional evidence for structure at the ellipsis site comes from syntactic island effects. Islands are a class of syntactic contexts that block filler-gap dependencies (Ross, 1967). For example, the wh-island constraint blocks the formation of a filler-gap dependency across an embedded sentence introduced by a wh-phrase. To illustrate, establishing a dependency across the embedded sentence introduce by *why* in (14a) results in unacceptability. When the intervening wh-phrase is removed extraction is acceptable (14b). The same contrast holds for VP-ellipsis in (15), suggesting that the same structure is present in (15) as in (14) (Haïk, 1987; Johnson, 2001).

14. a. *I know which book Meg read, and which book$_i$ Mr. Yunioshi asked why you hadn't read t_i.
b. I know which book Meg read, and which book$_i$ you hadn't read t_i.

15. a. *I know which book Meg read, and which book$_i$ Mr. Yunoshi asked why you hadn't ~~read~~ t_i
b. I know which book Meg read, and which book$_i$ you hadn't ~~read~~ t_i

However, there are instances where ellipsis shows insensitivity to syntactic island constraints (Ross, 1969). Despite the ban on extraction from a relative clause (16a) or a coordinate structure (17a), interpretatively parallel cases of sluicing are judged to be acceptable (16b, 17b).

16. a. *John met a guy who speaks a very unusual language, but I can't remember which language$_i$ John meet [$_{NP}$ a guy [$_{RC}$ who speaks t_i]].
b. John met a guy who speaks a very unusual language, but I can't remember which language$_i$ ~~John met a guy who speaks~~ t_i.

17. a. *Irv and someone were dancing together, but I don't know who$_i$ Irv and t_i were dancing together.
b. Irv and someone were dancing together, but I don't know who$_i$ ~~Irv and~~ t_i ~~were dancing together.~~

Contrasts such as (16–17) have been used to argue for the absence of structure inside the ellipsis site. If the ellipsis site hosts a null copy of the antecedent, then presumably the sluicing sentences should be just as bad as the sentences without sluicing (see Culicover and Jackendoff, 2005 for discussion). This argument assumes that island constraints apply to all syntactic structures, regardless of whether they are phonologically overt. An alternative approach to the contrast to (16–17) retains the null copy analysis, but assumes that island constraints are restrictions on phonologically realized structures. Under this view, ellipsis may be regarded as a kind of 'repair' operation that salvages the acceptability of an island violation (Fox and Lasnik, 2003; Merchant, 2008).

In contrast, variants of the pointer account claim that ellipsis is a form of anaphora. On this view, ellipsis sites and pronouns receive a uniform analysis, in the regard that they lack internal syntactic structure. For various implementations of this approach see Hardt (1999a,b), Ginzburg and Sag (2000), and Culicover and Jackendoff (2005).

2.4. The derivational status of ellipsis

The position papers in this special issue are all variants of the null copy account, and assume that the ellipsis site has internal structure. Their point of divergence, however, is in the derivational status of this unpronounced structure, within a transformational account of syntax that assumes that syntactic structures consist of a sequence of representations that relate an underlying representation of thematic/selectional relations onto phonological (PF) and logical form (LF) representations (Chomsky, 1981, 1995). This brings us to the next level of the decision tree in Fig. 1. Within this general approach, some accounts assume that the syntactic structure in the ellipsis site is present throughout the syntactic derivation, and is only marked for non-pronunciation at the phonological level (Ross, 1969; Sag, 1976; Lasnik, 2001; Merchant, 2001, 2008). Another approach assumes that structure is present at the ellipsis from the beginning of the syntactic derivation, but that this structure undergoes deletion at some point prior to the pronunciation of the sentence

(Baltin, 2012). This approach differs from the phonological non-pronunciation account in the respect that the ellipsis site lacks internal structure at LF. The third logical possibility claims that the ellipsis site initially lacks internal structure, and that structure is inserted via a structure copying operation at LF (Wasow, 1972; Williams, 1977; Fiengo and May, 1994; Chung et al., 1995; Lappin, 1999; Li, 2013; Merchant, 2013).

Hence, the derivational status of the structure in the ellipsis site is the main feature that distinguishes the different accounts featured in this special issue. Syntacticians commonly talk about the steps in their derivations in terms that make them sound like sequences of operations in time. But it is rare indeed for this to be intended as a claim about real-time processes (for discussion see Phillips and Lewis, 2013). It is commonly assumed that parsing involves the construction of the full syntactic representation of a sentence, including the thematic and logical form representations. This view has a long history, dating back to the 'coding hypothesis' of the late 1960s and early 1970s (Fodor et al., 1974). But this does not amount to a claim that there is any temporal priority for one level of representation over another. In incremental parsing/interpretation the surface, thematic, and logical form interpretations are presumably assembled in parallel. It is highly unlikely, for example, that the full surface structure of the sentence is built before construction of the LF begins. For this reason it is difficult to derive concrete timing predictions from theories that contrast primarily in their assumptions about the derivational status of ellipsis.

2.5. Experimental studies on ellipsis

Experimental studies on ellipsis can be classified according to which of the theoretical choice points in the decision tree in Fig. 1 they address.

I. Mismatching antecedents: A number of studies have explored the status of ellipsis constructions in which the syntactic form of the antecedent is incompatible with the ellipsis site. These studies have focused on acceptability rating measures, and have identified a cline of acceptability for various types of antecedent-ellipsis mismatches (Arregui et al., 2006; Kim et al., 2011). These studies have found that acceptability tends to decline as the syntactic mismatch between the antecedent and the ellipsis site becomes larger. These findings are relevant for the question of whether the antecedent for ellipsis is syntactic or semantic in nature. Mismatches have previously been presented as evidence for the claim that ellipsis is licensed by a semantic antecedent, but the acceptability cline has been used to argue that ellipsis requires a syntactic antecedent, with the caveat that the syntactic antecedent may require extra-grammatical repair (Arregui et al., 2006) or it may be obscured by a syntactic derivation (Kim et al., 2011).

II. Accessing antecedent information: A number of different studies of ellipsis have examined what information about the antecedent is accessed on-line, and how quickly. These studies span a wide range of experimental techniques, including cross-modal lexical decision (Shapiro and Hestvik, 1995; Shapiro et al., 2003), reading time (Yoshida et al., 2012a,b), event-related brain potentials (ERPs: Kaan et al., 2004; Martin et al., 2012), speed-accuracy tradeoff (SAT: Martin and McElree, 2008, 2009, 2011), and visual fixations in a scene (Snider and Runner, 2011). These studies generally find that information about the antecedent is accessed rapidly, and interesting further questions are asked about whether processing ellipsis involves accessing lexical items from the antecedent, and whether connectivity effects are rapidly computed. These studies are commonly framed as attempts to determine what structure, if any, is represented at the ellipsis site. But our impression is that the evidence typically demonstrates what information is accessed about the antecedent, which need not entail any conclusions about the copying of structure to the ellipsis site.

III. Does size or distance matter? A few studies have investigated whether the size of the ellipsis antecedent or the distance to the antecedent impacts the timing of ellipsis resolution (Murphy, 1985; Frazier and Clifton, 2000, 2001; Martin and McElree, 2008, 2009, 2011). There is an emerging consensus that the size of the antecedent does not matter, but we argue below that the evidence remains inconclusive. These studies are typically framed as addressing questions about what structure is represented at the ellipsis site, but they could equally well be understood as being informative only about the process of accessing the antecedent in memory.

As a spoiler, we should state at the outset that we are skeptical of the prospects for using experimental evidence on the timing of ellipsis resolution to address questions about the 'derivational timing' of ellipsis in syntactic theories. Since the syntactic theories typically disavow claims about how their operations map onto real-time processes, it should be unsurprising that it is difficult to arbitrate between them based on timing evidence.

3. Theme 1: antecedent-ellipsis mismatches

A central theme in the linguistics of ellipsis is the representation of the antecedent. As discussed in section 2.2, formal accounts of ellipsis agree that the ellipsis-antecedent relation is subject to an identity requirement of some kind, but they differ in terms of what type of representation the identity requirement applies to. Syntactic accounts claim that the identity condition is syntactic, and hence that elided information is recovered from the syntactic representation of the antecedent (Sag, 1976; Williams, 1977; Lappin, 1992, 1996; Fiengo and May, 1994; Hestvik, 1995). The syntactic identity requirement is motivated by cases of antecedent-ellipsis mismatches that are judged to be unacceptable (18). Contrasts such as these have been

corroborated experimentally. For example, Tanenhaus and Carlson (1990) report that VP-ellipsis is accepted more often in a ''make sense'' task when the antecedent is syntactically parallel, as in (18a), than when it is not (18b).

18. a. John looked into this problem, and Bill did ~~look into this problem~~ too.
b. *This problem was looked into by John, and Bill did ~~look into this problem~~ too.

However, as discussed above, there are also many reported cases of apparently acceptable antecedent-ellipsis mismatches, such as the voice mismatches in (19–21), repeated from (7–9) above. If the mismatches are genuinely acceptable, then they are more consistent with the notion of a semantic identity condition (Dalrymple et al., 1991; Hardt, 1993; Kehler, 1993). Of course, the challenge for a semantic account of the identity condition is that it runs the risk of overgeneration.

19. This problem was to have been looked into, but obviously nobody did ~~look into this problem~~.
(Kehler, 2000)

20. Of course this theory could be expressed using SDRSs, but for the sake of simplicity we have chosen not to ~~express this theory using SDRSs~~.
(Lascarides and Asher, 1993)

21. In March, four fireworks manufacturers asked that the decision be reversed, and on Monday the ICC did.
(Rosenthal, 1988)

A number of psycholinguists have recently attempted to resolve the tension between evidence for syntactic and semantic identity conditions by exploring the possibility that antecedent-ellipsis mismatches are not straightfowardly acceptable, and instead reflect a systematic cline of acceptability, which can be explained by appeal to language processing operations (Arregui et al., 2006; Kim et al., 2011). In effect, these represent a novel way of maintaining a syntactic identity account in the face of acceptable mismatches.

Arregui et al. (2006) report an acceptability cline across various forms of antecedent-ellipsis mismatches. In an offline acceptability judgment study they found that a passive–active mismatch (22a) was judged as more acceptable than an active–passive mismatch (22b). They also found that ellipsis with a verbal gerund as an antecedent for a VP (23a) was judged as more acceptable than ellipsis with a nominal gerund as antecedent (23b). Kim et al. (2011) provide converging evidence for these generalizations from a magnitude estimation study. In addition to the acceptability contrasts between the passive/active alternations, they also observe contrasts of acceptability across category mismatches (23).

22. *Passive–Active* > *Active–Passive*
a. The dessert was praised by the customer after the critic did already.
b. The customer praised the dessert after the appetizer was already.

23. *Verbal Gerund* > *Nominal Gerund*
a. Singing the arias tomorrow night will be difficult, but Maria will.
b. Tomorrow night's singing of the arias will be difficult, but Maria will.

24. *Noun-VP* > *Adjective-VP*
a. The criticism of Roy was harsh, but Kate didn't.
b. The report was critical of Roy, but Kate didn't

There are several possible ways of accounting for the cline in acceptability of antecedent-ellipsis mismatches, all of which assume that there is a syntactic identity constraint, but that there is a more flexible relation between surface forms and the manner in which the identity constraint is satisfied.

Aregui and colleagues assume that the syntactic identity constraint applies immediately upon encountering an ellipsis site, and that it applies to a relatively surface-true representation of the sentence. This implies that antecedent-ellipsis mismatches are all ungrammatical. Arregui and colleagues propose that the cline of acceptability reflects the relative difficulty in carrying out repair operations that apply after initial detection of ungrammaticality. Specifically, they argue that the difficulty is proportional to the amount of repair work ('recycling') required to transform the surface form of the antecedent into a syntactically matching phrase. For example, the passive–active mismatch in (22a) is predicted to be more acceptable than the active–passive mismatch in (22b) because it requires less repair work to recover a simpler active form from a complex passive antecedent than vice versa. This contrast was documented in studies dating to the 1960s (e.g., Mehler, 1963).

Whereas Arregui and colleagues claim that the mismatches are instances of 'acceptable ungrammaticality' Kim and colleagues argue for the opposite view, that the mismatches are fully grammatical, but that the parser encounters varying degrees of difficulty in accessing the relevant grammatical form. They propose an account of syntactic encoding in which a canonical VP is part of the syntactic representation of all of the antecedent types in (22–24), but where this VP is masked by further steps in the derivation of the final surface form of the sentence. Given these assumptions, they propose that the cline of difficulty reflects the number of parser states or derivational steps that the processing mechanism must search through to recover a syntactically matching antecedent. Mismatching forms are assumed to require more search, and this additional search is claimed to be associated with lower acceptability.

Although the proposals by Arregui et al. and by Kim et al. make opposite claims about the grammatical status of the mismatches, they are very close to one another in terms of their appeal to parser operations as a way of accounting for the gradient acceptability of the mismatches.

The difference between the two accounts may be reduced to the amount of determinism assumed in the respective processing architectures. Kim and colleagues adopt a non-deterministic parsing procedure in which all possible derivational steps or parser states are computed in parallel. These states may be stored in a data structure, such as a chart (see Jurafsky and Martin, 2009 for discussion), that avoids the need for later re-parsing. Such a system would make extensive use of structure-sharing to resolve ellipsis. In the implementation suggested by Kim and colleagues, parser states are ordered according to their compatibility with a series of parsing preferences or heuristics, and stored in a separate data structure. The processor must search through the space of possible parses, testing each parse in turn until a syntactic match is recovered. By contrast, Arregui and colleagues assume that parsing is initially serial and deterministic. An implementation of their proposal would not maintain in parallel a store of all possible parser states. Because of this limitation, repair operations would have to make use of some sort of backtrack machinery to re-parse a mismatching form.

The focus of this line of experimental work on ellipsis has to-date been on documenting the cline of acceptability in antecedent-ellipsis mismatches, and there is little reason to choose between the view that the mismatches are ungrammatical-but-repaired and the view that they are grammatical-but-hard-to-recover. However, it is conceivable that future experiments might be able to resolve this issue, which has much in common with current debates about the grammatical status of such phenomena as island effects (Kluender, 1998; Hofmeister and Sag, 2010; Phillips, 2012; Sprouse et al., 2012) and agreement attraction (Wagers et al., 2009; den Dikken, 2001). For a review of these discussions see Phillips (2011).

4. Interlude: experimental arbitration of other theoretical disputes

The next stage in our review of experimental studies of ellipsis is the second branching of the decision tree in Fig. 1, which focuses on the question of whether null structure is represented at the ellipsis site. But in order to interpret the findings on ellipsis, it is useful to step back for a moment from the discussion of ellipsis to consider some psycholinguistic findings on other types of linguistic dependencies and what they have contributed to theoretical debates. Recent experimental studies on ellipsis cover similar ground to earlier studies on *wh*-movement and anaphora, and so it is informative to compare the arguments that are being made about related experimental effects in different domains.

Debates about phonologically unrealized ('null') structure can be found in the literature on ellipsis, *wh*-movement, and anaphora alike. Some theoretical accounts of ellipsis assume that the full structure of the elided material is represented in the ellipsis site, despite the fact that it has no phonological reflex. This assumption is shared by the papers by Merchant and Li in this special issue. Other accounts of ellipsis argue that the ellipsis site merely contains a null pro-form or a 'pointer' that links the ellipsis site to the antecedent (Tanenhaus and Carlson, 1990; Culicover and Jackendoff, 2005; Martin and McElree, 2008; Hardt, 1993).

These alternatives parallel well-known debates about *wh*-movement and other types of unbounded dependencies. Theories of transformational grammar since the mid-1970s have claimed that the gaps created by *wh*-fronting, relativization, and topicalization (among others) are phonologically empty but not syntactically empty, i.e., the gap contains phonologically unrealized structure (Chomsky, 1977; Fiengo, 1977). In different variants of transformational grammar this gap contains a *trace*, which is roughly a null bound variable pronoun that is coindexed with the fronted phrase, or a null copy of the fronted phrase. This contrasts with theories that argue that fronted phrases are directly linked to the verb that selects them, with no need for mediation via phonologically empty categories (e.g., Pickering and Barry, 1991; Pollard and Sag, 1994).

Although they are less widespread, some theories of anaphora make similar claims about the syntactic representation of the pronoun. Postal's pronominalization account of pronouns claimed that a pronoun is transformationally derived from a full representation of the antecedent (Postal, 1969; Elbourne, 2001). More recent approaches such as the movement theory of control (Hornstein and Polinsky, 2010) and the movement theory of reflexives (Lidz and Idsardi, 1998; Hornstein, 2001) have similarly argued that PRO and reflexives are derived from a full representation of the antecedent, which subsequently undergoes movement. These approaches contrast with the more common view that anaphoric elements do not contain additional null structure, and instead pick up their content through their relation to their antecedent.

For some reason these similar debates have generated very different amounts of controversy in the different subfields. Claims about null structure in anaphora are generally tolerated but rarely attract enough attention to generate much debate. In contrast, there have been vociferous disputes about the need for null structure in *wh*-dependencies, and the avoidance of empty categories is regarded as a badge of honor in certain syntactic circles. Meanwhile, in the domain of ellipsis the corresponding debate is well known among experts, but the competing approaches are regarded as respectable alternatives, engendering none of the passion that accompanies discussions of empty categories for *wh*-movement dependencies.

There is an extensive literature on the processing of *wh*-dependencies, including much discussion of whether the on-line findings favor theories with or without empty categories. Despite initial enthusiasm that some experimental findings were theoretically decisive, either in favor of empty categories (McElree and Bever, 1989; Nicol and Swinney, 1989; Nakano et al., 2002; Lee, 2004) or in favor of direct association (Pickering and Barry, 1991), the current consensus is that the experimental evidence does not arbitrate for or against empty categories in *wh*-dependencies (Gibson and Hickok, 1993; Phillips and Wagers, 2007; Kempen, 2010). The reason for this is that the competing syntactic analyses do not make clear predictions about the timing of corresponding on-line processes. Interestingly, as we discuss in section 5 below, we now see similar arguments being presented as evidence for or against null structure in ellipsis. Meanwhile, some closely related issues have been explored in the processing of anaphora, but to our knowledge nobody has viewed this as evidence for a Postal-style pronominalization theory or for a movement theory of anaphora.

In research on *wh*-dependencies and anaphora a number of studies have tested what information about the head of the dependency is accessed at the tail of the dependency, i.e., what properties of the *wh*-phrase are accessed at the gap site, and what properties of the antecedent are accessed at the site of the pronoun or reflexive. In the late 1980s there was a flurry of interest in 'reactivation' of *wh*-phrases or relativized phrases at gap sites, as measured using cross-modal priming tasks. For example, Swinney and colleagues had participants listen to relative clause constructions as in (22) while performing a visual lexical decision task (Swinney et al., 1988). In the key trials the visual target word was either a semantic associate of one of the words in the sentence, or an unrelated but lexically matched control. Priming effects, i.e., faster lexical decision times to the related target word, were taken as evidence for the activation of the associate of the target. Targets were presented to coincide with different points in the auditory sentence, corresponding to the asterisks in (25). Results showed that associates of the relative clause subject *crowd* (e.g., 'group') were primed only at the first probe position, presumably because this was so soon after *crowd* had been heard. More importantly, associates of the relative clause head *boy* (e.g., 'girl') were primed at the second and third probe positions, i.e., immediately following the gap site. This suggested that the relative clause head is reactivated at the gap site. A number of further studies showed related effects of semantic reactivation of antecedents at gap sites, although the interpretation of these findings received differing interpretations (Nicol and Swinney, 1989; McKoon et al., 1994; Nicol et al., 1994).[4] A less well-known but related result showed reactivation of the phonological properties of the antecedent at the gap site, using a cross-modal rhyme-priming paradigm (Tanenhaus et al., 1985). Using sentences like (26) Tanenhaus and colleagues found faster lexical decision times to sentence-final words that rhymed with a preceding *wh*-phrase (e.g., *fear-beer*) than to non-rhyming pairs (e.g., *fear-wine*). More recently, studies using eye-tracking measures have reached similar conclusions about the activation of *wh*-phrases based on the time course of looks to pictures of the antecedent (Sussman and Sedivy, 2003; Omaki et al., 2009; Dickey and Thompson, 2009).

25. The policeman saw the boy that the crowd at the party * accused * of the * crime.

26. The man was surprised at which {beer|wine} the judges awarded first prize to.

These findings on the processing of filler-gap dependencies are certainly interesting, but there is general agreement that they are not decisive on the dispute about empty categories in *wh*-movement. Experiments such as these help us to precisely document the timing of *wh*-dependency formation, what information is carried forward in time and what information is reaccessed at the foot of the dependency (cf. Wagers and Phillips, in press). But this timing information is not informative about the representation of filler-gap dependencies, because the competing theories have a great deal of latitude in terms of predictions about the timing of dependency formation. Also, evidence about which properties of a filler phrase are accessed at the foot of a *wh*-dependency does not show whether there is unpronounced syntactic structure

[4] Note that there is an apparent tension between findings that suggest reactivation of a wh-phrase at the tail of wh-dependencies and evidence that wh-phrases are actively maintained in a privileged state during the search for a gap site (e.g., Stowe, 1986; Kluender and Kutas, 1993; Traxler and Pickering, 1996; Fiebach et al., 2002). Wagers and Phillips (in press) argue that this tension can be resolved by a distinction between active maintenance of coarse-grained information about the wh-phrase and rapid decay of finer grained information about the wh-phrase.

represented at the foot of the dependency. Reactivation of the lexical code of the filler may reflect construction of an empty category, or it may equally reflect construction of a direct link from a verb to the memory representation of the filler. This is similar to the 'pointer' mechanism invoked by some accounts of ellipsis.

In the domain of pronoun resolution, a number of studies have tested for effects of re-access to the phonological or lexical properties of the antecedent of the pronoun at the point of pronoun resolution. For example, in a pronoun production task in German, phonological properties of the antecedent were found to be accessed when the pronoun is processed (Schmitt et al., 1999). In pronoun comprehension tasks, reading times at the pronoun are affected by lexical properties of the antecedent, such as frequency (van Gompel and Majid, 2004; Lago et al., submitted for publication). These effects provide interesting information on the nature of the antecedent retrieval process for pronouns, but they have not been taken as evidence for a copying mechanism in anaphor resolution.

In light of the consensus view that existing evidence on the processing of filler-gap dependencies and anaphora does not adjudicate the question of whether there is null structure at the foot of the dependency, it would be advisable to apply similar reasoning when interpreting findings on the processing of ellipsis. For any argument for the representation of null structure in an ellipsis construction we should ask: would a corresponding argument convince us of the need for traces/gaps for *wh*-dependencies, or of the merits of a transformational account of anaphora?

5. Theme 2: accessing antecedents

Studies using various different experimental paradigms have been used to investigate what properties of ellipsis antecedents are accessed at the point of ellipsis resolution, and to track the time course of ellipsis resolution (Shapiro and Hestvik, 1995; Snider and Runner, 2010; Ysohida et al., 2011, Kaan et al., 2004; Martin and McElree, 2008, 2009, 2011). For example, some studies have asked whether processing of the ellipsis site involves accessing the semantics or the phonology of lexical items from the antecedent, and some have tested whether binding relations between elided and non-elided material are computed rapidly. They have yielded a number of interesting findings, generally demonstrating rapid access to information about antecedents. These studies are related to theoretical questions about whether structure is represented at the ellipsis site (see section 2.3), and they are often framed as providing experimental evidence on these questions. But for the reasons discussed in the previous section, we think that evidence on what information is accessed at an ellipsis site does not indicate what representations are constructed at an ellipsis site.

Shapiro et al. (2003) found evidence for reactivation of an antecedent direct object at the ellipsis site, as measured using a cross-modal priming paradigm. Participants listened to sentences like (27) while performing a lexical decision task. In key trials the visual target word was a semantic associate of the subject of the first clause, the object, or an unrelated control. Targets were presented to coincide with different points in the auditory sentence, corresponding to the asterisks in (27). Results showed that associates of the object noun *tie* (e.g. 'neck') were primed only at the second position, i.e., immediately following the auxiliary that introduced the ellipsis. No priming effects were observed in either position for associates of the subject noun *mailman* (e.g. 'stamp'). This suggests that only information contained inside the VP-antecedent, including the direct object, is accessed at the ellipsis site. Shapiro and colleagues presented these findings as evidence for construction of syntactic structure at the ellipsis site. However, for the same reason that similar arguments about *wh*-movement do not provide decisive evidence for traces or copies of moved phrases, we regard these findings as informative about the process of accessing the antecedent in memory, rather than about the existence of syntactic structure at the ellipsis site.

27. The mailman bought a tie for Easter, and his brother, who * was playing volleyball, did * too, according to the sales clerk.

In a recent study Snider and Runner (2011) ask similar questions using a different dependent measure, namely looks to pictured objects in a visual world eye-tracking paradigm. Participants listened to sentences like (28) while their eye movements were monitored. The focus of the study was on the pictured objects that were fixated when the ellipsis site was encountered. Displays included pictures of a noun from the antecedent VP ('lock'), and also semantic associates (Experiment 1, e.g., 'key') or phonological cohort members (Experiment 2, e.g., 'log'), in addition to distractor items. Snider and Runner argue that their results show increased looks to semantic and phonological associates of the noun in the antecedent, and that this in turn implicates the creation of structure at the ellipsis site. We agree that it is interesting if lexical properties of VP-ellipsis antecedents are accessed at ellipsis sites, but we do not agree that this entails that there is explicit structure in the ellipsis site. Snider and Runner's evidence motivates that conclusion roughly as strongly as Tanenhaus et al.'s (1985) rhyme-priming evidence (see (26) above) motivates traces of *wh*-movement.

28. The security guard opened the lock, and the night watchman did too.

Studies using self-paced reading have reached similar conclusions about accessing antecedent information during ellipsis resolution. Yoshida et al. (2012) showed rapid sensitivity to binding relations inside an antecedent for sluicing, a variety of clausal ellipsis. They used a clever design in which they presented sentences that did not contain sluicing, but that in some cases were temporarily compatible with a sluicing parse. For example, the fronted *wh*-NP in (29a) is initially compatible with a sluicing parse, but the fronted *wh*-PP in (29b) is not. They reasoned that if readers actively pursue a sluicing parse where available, and if they also rapidly resolve anaphoric relations, then there should be a gender-compatibility effect at the reflexive in (29a), reflecting the match between the reflexive and the subject of the sluiced clause ('grandfather', 'grandmother') but not in (29b). This is exactly what they found.

29. a. Jane's {grandfather | grandmother} told some stories at the family reunion, but we couldn't remember which story about *himself* from the party his brother was so very impressed with.
    b. Jane's {grandfather | grandmother} told some stories at the family reunion, but we couldn't remember with which story about *himself* from the party his brother was very impressed.

In another study, Yoshida et al. (2012a) also showed rapid sensitivity to island constraints in sluicing and sprouting constructions. They exploited the fact that sluicing involving an implicit argument ('sprouting') is sensitive to islands, but standard sluicing is not (Chung et al., 1995; Merchant, 2001, 2008, among others). (30a) illustrates sprouting: the *wh*-phrase *what* can be understood as associated with the direct object of the verb *smoked* in the antecedent clause, despite the fact that the antecedent clause contains no direct object. (30b) shows that sprouting is no longer available when it involves an adjunct clause ('because . . .'), an island for *wh*-movement. The sentences in (31) show that sluicing does not show the same degradation in adjunct island contexts. Yoshida and colleagues reasoned that inferring the unexpressed argument from the antecedent clause should make sprouting more costly to resolve than sluicing, and they confirmed this prediction in sentences like (32a) that did not contain an island structure. The adverb following *what* was read more slowly in the sprouting condition. More importantly, they showed that the slowdown was absent in sentences like (32b) that contain an adjunct island structure. They reasoned that the parser constructs detailed representations at potential sluicing/sprouting sites, thereby allowing it to rapidly recognize where sprouting is and is not available. These findings demonstrate impressive on-line sensitivity, but we submit that the reading time data does not strengthen evidence for structure at the ellipsis site. If the pattern of acceptability judgments involving islands and sprouting can be captured without assuming structure at the ellipsis site, then the reading-time data can equally be accounted for without assuming structure at the ellipsis site.[5]

30. a. Nick's father smoked, but it wasn't clear what ~~Nick's father smoked~~.
    b. *Nick's father was startled because he smoked, but it wasn't clear what ~~Nick's father was startled because he smoked~~.

31. a. Nick's father smoked something, but it wasn't clear what ~~Nick's father smoked~~.
    b. Nick's father was startled because he smoked something, but it wasn't clear what ~~Nick's father was startled because he smoked~~.

32. a. Nick's father discovered that he smoked {secretly | something} in the garden, but it wasn't clear *what* precisely he got out of smoking in hiding.
    b. Nick's father was startled because he smoked {secretly | something} in the garden, but it wasn't clear *what* precisely he got out of smoking in hiding.

Kaan et al. (2004) investigated the processing of gapping structures using event-related potentials (ERPs), and argued that their results favored an account in which a null copy of the elided ('gapped') verb is explicitly represented at the gap site, rather than an account in which the arguments of the verbless clause are directly associated with their counterparts in the antecedent clause (Dirksen, 1990; Dirksen and Kerstens, 1987). They manipulated the plausibility of the remnant noun (e.g. *hammer* in (33)), and found an N400 effect to the implausible verb-noun combination (i.e., *sanded-hammer*) at the remnant. This shows that gapping constructions are rapidly interpreted, but it does not show what the syntactic form of such constructions is. In a further analysis, Kaan and colleagues compared ERPs at the determiner *the* that immediately follows the gap with ERPs at post-verbal determiners drawn from various types of other sentences in the same study. This comparison showed a number of effects, including an early centro-posterior negativity, which the authors suggested might be related to the Early Left Anterior Negativity (ELAN) that has been elicited by gross violations of phrase structure rules in

[5] We should note that Yoshida et al. (2012a) are primarily concerned with evidence for island sensitivity in sluicing/sprouting, and their remarks about structure at the ellipsis site are not the focus of their study.

other studies (Friederici et al., 1993; Neville et al., 1991). Kaan and colleagues reason that since previous ELAN effects have been elicited by 'phrase structure violations' then the gapped structures that elicit similar effects must involve construction of phrase structure, and hence must involve an explicitly represented copy of the verb. Even setting aside the problems associated with comparing ERPs to words that are preceded by different lexical categories (which the authors acknowledge), we regard this argument for structure at an ellipsis site as tenuous.[6]

33. Ron {took | sanded} the planks for the bookcase, and Bill __ the hammer with the big head.

In sum, the studies reviewed in this section present interesting evidence on what information is accessed, and how quickly it is accessed, when ellipsis constructions are processed. But we do not think that they resolve the question of whether phonologically unrealized structure is represented at the ellipsis site.

6. Theme 3: does size/distance matter?

An alternative experimental approach to the question of whether structure is represented at ellipsis sites involves testing whether the complexity of the antecedent affects the speed or difficulty of ellipsis resolution. By hypothesis, if structure is explicitly represented at the ellipsis site, then generation of this structure at the point of ellipsis resolution should be impacted by the complexity of the antecedent. In this section we review the arguments on this topic. We argue that the consensus that complexity does not matter in ellipsis resolution is not warranted by the existing data.

Martin and McElree (2008) operationalize the copy mechanism involved in ellipsis resolution as a real-time structure building procedure. They argue that if ellipsis resolution involves a copy operation, then the temporal dynamics of ellipsis resolution should vary as a function of the size and complexity of the antecedent i.e., copying more material should take more time. In terms of memory retrieval mechanisms, a copy operation would require serial construction of structural relations in the antecedent at the ellipsis site. This prediction is based upon the assumption that the time needed to resolve the ellipsis should be proportional to the number of nodes and dependency links reassembled at the ellipsis site. If the copy mechanism engaged a parallel construction mechanism in which all nodes and grammatical relations are reassembled in parallel then the prediction would no longer hold.

We should note that time-course effects associated with antecedent complexity do not necessarily implicate a copy mechanism. The process of accessing a complex antecedent in memory could take more time than accessing an antecedent of lesser complexity, regardless of whether the reaccessed material is then copied into the ellipsis site. However, some authors have argued that the absence of a complexity effect provides clear evidence against a copy mechanism. Martin and McElree (2008:894) argue that ''The canonical interpretation of a literal copy mechanism is that copying more information should take more time. One could simply assert that 'copying' does not require time, but we suggest that in that case, the notion of 'copy' is no longer explanatory.''

6.1. Evidence for complexity effects

Murphy (1985) found that shorter antecedents yield shorter response times than longer antecedents. Using an end-of-sentence ''got it'' task, which measures the amount of time needed for a participant to signal that he had understood the test sentence, Murphy found that reaction times were on average 244ms shorter for ellipsis sentences with a short antecedent (33a) than for sentences with a long antecedent (33b).

33. a. *Short antecedent*
Jimmy [swept the tile floor behind the chair]

b. *Long antecedent*
Jimmy [swept the tile floor behind the chair free of hair and cigarettes]

c. *Ellipsis*
Later, his uncle did too.

Tanenhaus and Carlson (1990) challenge Murphy's conclusion, pointing out that the length manipulation in (33) introduced an attachment ambiguity that may have independently contributed to longer reaction times in (33b). They

[6] In a follow up study, Kaan et al. (2012) compared ellipsis structures to their fully-fledged counterparts, and interpreted the LAN component as a 'gap detector' rather than as evidence for structure at the ellipsis site. They suggested that integration of the elided material is on a par with the integration of a *wh*-object.

argue that a copy mechanism is not responsible for connecting a surface anaphor to its antecedent. Rather, they assume that anaphors are co-indexed with the antecedents, linked by a pointer to the antecedent.

6.2. Evidence for the absence of complexity effects

Frazier and Clifton (2000, 2001) provide preliminary evidence for the absence of complexity effects in ellipsis resolution. Frazier and Clifton (2000) found that the antecedent-length manipulation in (34a–b) did not impact self-paced reading times for the ellipsis sentence (34c). They interpret this result as evidence that copying is ''cost free'', i.e., copying more structure does not engender more processing time than copying less structure (Frazier and Clifton, 2001). Note that this is exactly the kind of claim about copying that Martin and McElree (2008) describe as non-explanatory.

34.	a.	Sarah left her boyfriend last May.	*Short antecedent*
	b.	Sarah got up the courage to leave her boyfriend last May.	*Long antecedent*
	c.	Tina did too.	*Ellipsis*

The finding from Frazier and Clifton (2000, 2001) is sometimes cited as evidence for the absence of antecedent complexity effects in ellipsis resolution. However, this finding should be treated with caution. First, readings times in this study numerically trended toward longer reading times in the long antecedent condition, by as much as 50 ms in some comparisons. The difference was not statistically reliable, but this could reflect reduced power in the study, due to the relatively low number of target items (12 total). The critical reading times were measured in the final sentence region, a practice that is generally avoided in self-paced reading studies, due to spill-over and end-of-sentence wrap-up effects (Just and Carpenter, 1980). Also, the use of intermittent comprehension questions, rather than comprehension questions on every trial, may have reduced participants' motivation to deeply process the ellipsis sentences.

More recently, Martin and McElree (2008) conducted a series of speed-accuracy tradeoff (SAT) experiments to determine whether antecedent information is copied to the ellipsis site. The response-signal SAT procedure probes participants for a binary sensicality judgment at cued intervals after the onset of the ellipsis phrase. The result is a curve that describes the growth in sensitivity to semantic congruity as a function of time. Unlike standard reaction time paradigms such as self-paced reading, SAT does not conflate differences between processing speed and the success of interpretation into a single mean reaction time. SAT measures the rate that sensitivity to semantic congruity rises to asymptotic accuracy, separating the speed of processing and accuracy of completing the task into two independent parameters.

Martin and McElree found that the complexity manipulation in (35) affected neither the temporal dynamics nor the asymptotic accuracy of sensitivity to the plausibility of the ellipsis. Most important here is the finding that the time-course of processing did not differ between the simple and complex antecedent conditions. They interpret the time course of the sensitivity function as a reflection of the time needed to retrieve the antecedent and to interpret it at the ellipsis site. Since retrieval and interpretation is unaffected by the size of the antecedent, they conclude that ellipsis resolution is mediated by a pointer mechanism, an analysis they term ''retrieval in-situ'' (Martin and McElree, 2009). In other words, they interpret the lack of complexity effects as evidence for a lack of structure at the ellipsis site.

35. a. *Simple antecedent*
The history professor [understood Roman mythology], but the principal was displeased to learn that {the over-worked students/*the overly worn books} attending summer session did not.

b. *Complex antecedent*
The history professor [understood Rome's swift and brutal destruction of Carthage], but the principal was displeased to learn that {the over-worked students/*the overly worn books} attending summer session did not.

Martin and McElree's task avoids some of the limitations noted for Frazier and Clifton (2000, 2001). However, the sensicality judgment task used in this study is a fair test of antecedent complexity effects only if the complexity of the antecedent is task-relevant. This was probably not the case. In both the simple and complex antecedent conditions in (35) the sensicality judgment depends on the relation between the subject of the embedded sentence (*the over-worked students* vs. **the overly-worn books*) and the verb of the antecedent clause *understood*. The selection mismatch between *books* and *understood* can be detected without processing the rest of the antecedent VP, and hence the complexity manipulation was not task relevant. Also, Martin and McElree's conclusions depend on the assumption that a copy mechanism would not engage a mechanism that constructed the elements of an antecedent VP in parallel, something that is a distinct possibility.

In sum, we think that the current lack of evidence for antecedent complexity effects in ellipsis resolution is not yet conclusive, and an improved version of Martin and McElree's studies is needed. This would need to test for detection of anomalies in ellipsis resolution that depend on interpretation of the entire antecedent VP, rather than just on the head of the antecedent VP. This is not as straightforward as it looks. One could try to create complex VP antecedents that require grammatical licensing of an element deeply embedded inside them, and then fail to provide a suitable licensor in the clause targeted by ellipsis. However, the challenge for this approach is that many constraints on grammatical dependencies are obviated by VP-ellipsis, as pointed out by Hardt (1993), making them unsuitable for this kind of test.

6.3. Complexity effects in other domains of sentence comprehension

It is not clear whether the predictions and results from the ellipsis complexity studies are compatible with existing analyses of antecedent complexity effects observed for other types of linguistic dependencies. Complexity effects in filler-gap resolution have been interpreted as reflecting the cost of accessing an antecedent, and not as evidence for structure copying to the gap site. In addition, it has been claimed that in filler-gap processing more complex antecedents sometimes lead to shorter reading times at the foot of the dependency. For example, Hofmeister (2007) found that sentences with a larger wh-antecedent (4b) engender shorter reading times at the verb than sentences with a bare wh-antecedent (4a). He attributed this difference to elaboration or depth of encoding in memory. Therefore, the direction of any effect of antecedent complexity effect is not to be taken for granted in studies of ellipsis resolution.

36. a. [What] did the reporter that Scooter avoided discuss __ during an evening news segment?
    b. [Which political poll] did the reporter that Scooter avoided discuss __ during an evening news segment

Summarizing, there is an emerging consensus that the size or complexity of the antecedent does not affect the temporal dynamics of ellipsis resolution (with different theoretical conclusions drawn from this generalization). This consensus however is not strongly motivated by the available evidence. In particular, confidence in interpreting these results is reduced by various confounds in experimental design. As such, key experimental studies on effects of antecedent complexity in ellipsis resolution remain to be carried out.

6.4. Locality (non-)effects in ellipsis resolution

A further question studied by Martin and McElree (2008, 2011) in their studies of ellipsis is how ellipsis resolution is impacted by the distance between the ellipsis site and the antecedent. Using the SAT paradigm, they manipulated the amount of material that intervened between an ellipsis site and its antecedent. They found that adding a long embedding clause in VP-ellipsis (37) or moving the position of an adverbial phase in sprouting (38) impacted asymptotic accuracy of acceptability judgments, but failed to impact the time course of judgments. Based on these non-effects of distance, they concluded that ellipsis is resolved by a cue-dependent direct access memory mechanism that probes the entire sentence representation in parallel. Under this account, constraints that are active at the ellipsis site, such as identity (whether syntactic or semantic) are used as cues for accessing the antecedent representation in memory. This suggests that a suitable linguistic account of ellipsis should have the property that constraints should readily be translated into retrieval cues for use in on-line ellipsis resolution.

37. The editor admired the author's writing, but (everyone at the publishing house was shocked to hear that) the {critics | *binding} did not.

38. (In the morning) Michael studied (in the morning), but he didn't tell me {what | *which}.

7. Conclusions

Recent years have seen ellipsis join the list of linguistic topics that has been productively explored using methods from psycholinguistics. As is often the case, this work has been accompanied by the promise of resolution to long-standing theoretical debates. As we have tried to explain here, the findings to date have revealed many insights about the processing of ellipsis, but caution is required in mapping findings about the timing of ellipsis resolution onto theories of the representation of ellipsis constructions. We outlined three primary issues that have drawn theoretical attention, and assessed the contributions of language processing research in each. The first theoretical question involves the nature of the antecedent for ellipsis, and the appropriate formulation of the identity condition on ellipses and their antecedents.

In this area, experimental investigations are starting to address the tension between syntactic identity constraints that tend to undergenerate and semantic identity conditions that tend to overgenerate. The second theoretical question is whether there is evidence for phonologically null structure at the ellipsis site. A number of experimental studies that have been framed as addressing this question. We argued that they have provided much information on the speed and sophistication of ellipsis resolution, but that they do not, in general, distinguish evidence on how antecedents are accessed from evidence on how the ellipsis site is represented. The third theoretical debate, which is the focus of a number of the papers in this issue, involves the question of the 'derivational timing' of ellipsis in a transformational grammar. We argued that experimental findings have little to offer on this topic, since the theoreticians' notion of 'timing' in this case has little to do with the more commonsense notions of timing that are tested in sentence processing studies.

Acknowledgments

Preparation of this paper was supported in part by NSF-IGERT award DGE-0801465 to the University of Maryland and NSF award BSC-0848554 to CP. Thanks are due to Masaya Yoshida, Matt Wagers, and Roumyana Pancheva for filling many holes in our knowledge, as well as to Mark Baltin and two anonymous reviewers.

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