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LIMITED, SYNTACTIC REACTIVATION IN NOUN PHRASE ELLIPSIS

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Abstract

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Chelsea Ann Miller

A long-standing question concerning ellipsis considers the nature of the representations that mediate interpretation at ellipsis sites. The present study asks what kind of material contained in the representation is used in real-time ellipsis processing.

A probe is needed to investigate the nature of the reactivated representation. Number features are used, as these can feed agreement attraction (AA), a process sensitive to morpho-syntactic information. In AA, an intervening, plural NP—the attractor—agrees with the verb as opposed to the singular, head noun containing it.

[The key$_{\text{Head Noun}}$ to [the cabinets$_{\text{Attractor}}$]$_{\text{PL}}$]$_{\text{SG}}$ were$_{\text{PL}}$ on the table.

When NPE elides an AA-triggering NP, would an attractor in the antecedent generate attraction when reactivated at the ellipsis site? Depending on how exhaustive reactivation is, different sets of number features may be reactivated. If the antecedent were reactivated fully—including the attractor—attraction is predicted; but if reactivation is only partial—just the head noun—no attraction is predicted. Based on the results of four reading-time experiments examining Noun Phrase Ellipsis (NPE), the data support that only limited syntactic information is reactivated, i.e., reactivation is partial.

Dedication

For my Dad.

"I feel more like I do now than I did before."

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1 Introduction

Ellipsis is a term which can be broadly construed: it describes generally cases where words are missing, but more specifically, it characterizes a class of constructions where material may go unpronounced.

Eliding material, i.e., going unpronounced, happens frequently and with ease. In fact, utterances without ellipsis may even be dispreferred. For example, compare the elliptical construction given in (1), here Verb Phrase Ellipsis, to its non-elliptical counterpart in (2).

(1) John should do the homework and Bill should, too.

(2) John should do the homework and Bill should do the homework, too.

In (1), the second clause has been elided. The clause '*Bill should*' means '*Bill should do the homework*', even though the verb phrase *do the homework* is not present; (1) has the same meaning as (2). The second clause is understood to have this, and only this, meaning, though it is not present. The elided sentence in (1) is more natural than uttering the clause in its entirety, (2), which sounds redundant and slightly clunky.

Given its naturalness, it may seem trivial to omit material that is redundant. However, a puzzle emerges when considering the perspective of the comprehender. If a goal of language is to effectively and easily communicate, the occurrence of ellipsis is not trivial—it is surprising. Ellipsis increases the burden placed on the listener. The listener is left to deduce what the meaning of the silence, which is a more difficult task.

Language is understood by deriving a meaningful interpretation (via whatever rules, algorithms, mappings, etc., necessary) from some linguistic input. In part, ellipsis has gathered much theoretical interest because it instantiates a case where the application of those mechanisms is not straightforward; how is meaning derived when there is nothing overt? For the case of (1), how is the meaning '*do the homework*' derived from silence?

Understanding language requires some mapping from input to meaning and ellipsis requires that part of that meaning be mapped onto silence. Further, there is an additional 'mapping' that must hold for ellipsis. Ellipsis is not felicitous out of the blue, but requires an overt, linguistic antecedent from which it's meaning is understood.

(3) #John might, too.

(4) Bob might [go to the store] and Bill might, too.

Example (3) cannot be uttered without prior context and be understood; it is not clear what John might do. (4), by contrast, is completely clear as to what Bill might do, which is *go to the store*. The verb phrase *go to the store* serves as the antecedent for the ellipsis site. (3) is not felicitous due to it's lack of an antecedent. The 'mapping' for ellipsis, then, is more complicated. In a non-elliptical string, the input is mapped to meaning in the regular way. In an elliptical string, meaning is mapped to the input, and upon encountering the silence of ellipsis in the input, that silence is mapped to it's antecedent, then to meaning.

This relation between antecedent and ellipsis site comprises much of the work on ellipsis. To treat ellipsis this simply, though, misses much of the complexity of the construction. Ellipsis requires the understanding of three, distinct parts: the nature of the antecedent, the nature of the ellipsis site, as well as the relation that then holds between them. At present, it is the nature of the ellipsis site itself that is of interest.

This investigation is reframed in terms of reactivation. Prior work has illustrated that other constructions which require antecedents cause reactivate of their antecedents when the element dependent on the antecedent is encountered. Here, that dependent element is the ellipsis site. If ellipsis does involve reactivation, it remains unclear what the nature of this reactivated representation is or how much material is reactivated. These two questions form the central research questions of the present study: What is the nature of the representation that is reactivated at ellipsis sites? and How much information is reactivated at ellipsis sites?

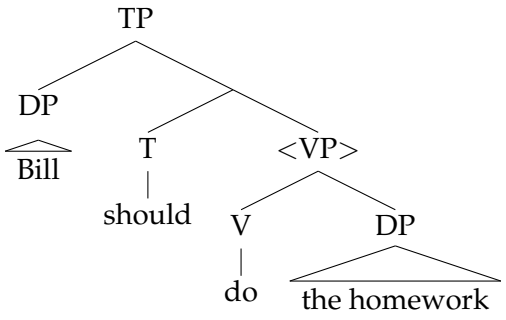
2 Background

2.1 Syntactic & Semantic Accounts of Ellipsis

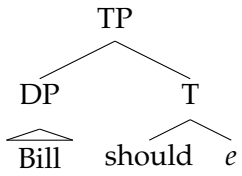
Theoretical literature on ellipsis can be roughly grouped into two camps: syntactic and non-syntactic analyses. Syntactic theories posit that, at some point, syntactic structure is required to understand the elided material. Ellipsis constructions are not devoid of syntax, but rather, contain the syntactic structure of a pronounced clause, that goes unpronounced. Semantic accounts require only a semantic representation. This representation structure, but not this fully elaborated syntactic structure. Consider the example from (1), reproduced below as (5), which illustrates how a syntactic theory would differ from a semantic theory with respect to the representation at the ellipsis site, i.e., the material that occurs within the angled brackets.

(5) John should do the homework and Bill should $< >$, too.

(6)



(7)



The representation in (6) is representative of a syntactic account; the verb phrase is not pronounced, as illustrated by the angled brackets surrounding the elided VP constituent, but full structure is present. This differs from (7), where there is no syntactic material at the ellipsis site.

There is a further distinction to be made, which has been characterized as the Structure Question and the Resolution Question (Xiang, Grove, & Merchant, 2014):

Structure Question

In elliptical constructions, is there syntactic structure that is unpronounced?

Resolution Question

Is understood material in the ellipsis resolved by the reference to the (syntactic) structure and meaning of its antecedent, or just to the meaning?

Recall that ellipsis can be broken down into three parts: the antecedent, the ellipsis site, and their relation. At present, the nature of the antecedent is set aside, however, investigations examining the antecedent requirement and what constitutes a viable antecedent has been a rich area of study (Hankamer and Sag (1976); Arregui, Clifton, Frazier, and Moulton (2006); Kim, Kobele, Runner, and Hale (2011)). What the Structure Question and Resolution Question aim to address are nature of the ellipsis site and the nature of the relation between antecedent and ellipsis site, respectively. These questions can be re-labelled as follows: Ellipsis Site Question and Relation Question.

The majority of the literature on ellipsis has addressed the Relation Question: what is the requirement that must hold, i.e., what is the relation, between antecedent and ellipsis site? This is often discussed in terms of the identity that is required between an antecedent and ellipsis site in order for the ellipsis to be felicitous. The identity retirement captures that, generally, the antecedent and ellipsis site are isomorphic, though there are notable, acceptable mismatches that these requirements must also account for. Syntactic accounts posit that identity must hold over terminal nodes of a structure (Chung, Ladusaw, and McCloskey (1995); Frazier and Clifton Jr (2001); Fiengo and May (1994)); semantic accounts require identity of a proposition, or of what is entailed in the antecedent and ellipsis site (Hardt (1993); Dalrymple, Shieber, and Pereira (1991)); others appeal to hybrid accounts, which have both structural and semantic requirements (Kehler and Kehler (2002); Chung (2013), Merchant (2013b)).

The present study situates itself under the Ellipsis Site Question; it is the nature of the reactivated representation that is of interest. This is clearly distinct from the Relation Question. If these questions address different aspects of ellipsis, perhaps this distinction need not be noted. However, answers to the Relation Question have been used to argue for answers to the Ellipsis Site Question. The logic is as follows. If iden-

tity is required, that identity may need to hold over the same type of representation. If the antecedent is of a certain nature, and needs to be identical to the ellipsis site, then perhaps the ellipsis site is of that same nature. In other words, the nature of the antecedent implicates the nature of the ellipsis site. Such claims are tenuous for two reasons. The first is that the relation between antecedent and ellipsis site remains unclear. Second, even if the relation were completely understood, this only makes an indirect argument for the Ellipsis Site Question.

The following section reviews prior experimental literature with respect to this distinction between Ellipsis Site and the Relation that holds between the ellipsis site and the antecedent.

2.2 Psycholinguistic Investigations of Ellipsis

Initial theoretical work on ellipsis focused on constructions where some information had gone missing, such as in (8) and (9).

(8) Bob didn't empty the trash can.
Mark did.

(9) Context: [John enters the room and sees the trash can has been emptied]
Mark did it.

In (8) *Mark did* seems strikingly similar to *Mark did it* in (9), save for the appearance of the pronoun *it* in the latter. In fact, these two constructions have the same meaning: Mark emptied the trash. Such instances were treated the same as both appear to be missing the same kind of material—the verb phrase—and have identical interpretations. However, there is crucial difference between (8) and (9). (8) is an example of ellipsis, as has been previously seen, while (9) is a deep anaphor. As illustrated in the example above, deep anaphors permit a non-linguistic antecedent, as given by the context. Ellipsis on the other hand, requires an antecedent, as was previously illustrated Hankamer and Sag (1976). The crucial point here is that ellipsis distinguishes itself

because of its antecedent requirement. This distinction was cached out theoretically by appealing to differences in the level of representation that is used to resolve deep anaphors and ellipsis: deep anaphors access a semantic representation whereas ellipsis must access a syntactic representation.

This theoretical distinction was explored in terms of processing. These investigations fell under the umbrella of the 'correspondence hypothesis'; appealing to the access of different representations should result in real-time processing differences between deep anaphors and ellipsis. Specifically, in processing differences at the ellipsis site itself. Thus, even this initial work hinted at both the Ellipsis Site and Relation Questions. The requirement of an antecedent addresses the Relation Question while the correspondence hypothesis, in a way, address the nature of the Ellipsis Site. Results emerged in favor of this hypothesis (Tanenhaus & Carlson, 1990), but also against (Murphy, 1985). Given the equivocal state of these investigations, attention was turned to the unique property of ellipsis: the antecedent requirement.

Manipulating the antecedent allows for a window into the nature of the antecedent, potentially the Relation Question, and indirectly, the Ellipsis Site Question. Ellipsis requires a syntactic antecedent, but how that syntactic antecedent is represented could be either syntactic or semantic. There is a distinction between the form of the antecedent, and the form of the representation which encodes the antecedent. It is this latter question about the representation that was first investigated.

The nature of the representation of the antecedent and ellipsis site are assessed via manipulating the complexity and distance of the antecedent from the ellipsis site. If the representation accessed is syntactic, both the complexity (number of nodes within some structure) and the distance (hierarchical distance) should incur processing difficulty. Manipulations in distance address the nature of the antecedent. As hierarchical distance increases, there is more structure that must be 'traversed' in order to locate the antecedent. If the representation were semantic, there would be no such structure to traverse. Complexity manipulations offer a window into the ellipsis site. If the

antecedent is interpreted at the ellipsis site, antecedents that are larger should incur greater costs as more time should be taken to interpret larger antecedents. This correlation would not follow for semantic representations, as they would be devoid of full, syntactic structure. As complexity is defined here over the number of nodes, no structure means no nodes, so no complexity effects would be predicted if the representation were semantic. Again, though, the literature offers diverging results: complexity and distance are seen to impact the time course of ellipsis resolution (Frazier and Clifton Jr (2001); Martin and McElree (2008); Martin and McElree (2009)), but these effects are not found across all studies Murphy (1985). When found, the effects distance support that the antecedent is syntactic, and effects of complexity, that the ellipsis site may contain structure. However, this picture is further complicated by theories which do not predict distance or complexity to have an effect, even when syntactic structure is involved. This is the case under systems that involve cost-free copying mechanisms (Frazier & Clifton Jr, 2001) or content-addressable pointers (Martin & McElree, 2008). Thus, experiments appealing to distance and complexity are similarly inconclusive, given both the diverging experimental results and that there are mechanisms that would not predict these effects. The Ellipsis Site Question remains unanswered.

To more directly assess the Ellipsis Site Question, another robust area of research investigated voice mismatches in ellipsis. Experiments examining these mismatches constituted the initial experimental evidence for the correspondence hypothesis (Murphy, 1985); ellipsis is sensitive to voice mismatches, while deep anaphors are not. The resulting ungrammaticality was used to argue for a syntactic theory of ellipsis, with syntactic structure present in both the antecedent and ellipsis site. In terms of syntax, differences in voice are due to differences in structure. Semantically, however, what is entailed by the proposition in the active and the passive is the same. If the structure that encodes voice differs in the active and the passive, and identity holds over syntactic nodes, the antecedent and ellipsis site mismatch. Thus, the ungrammaticality of voice mismatches is due to a failure to adhere to identity. If a semantic representation is accessed, voice

mismatches should be felicitous as the semantic representations are the same—identity holds. The sensitivity to voice mismatches for only ellipsis provides evidence in favor of a syntactic theory. However, note this argument rests upon the idea that the nature of the antecedent and the nature of the ellipsis site are the same. As previously noted, this doesn't necessarily have to be the case, and further, this would require clear elaboration of what the answer to the Relation Question is.

Further, it has been noted that there are mismatches in voice that are completely acceptable Hardt (1993); Merchant (2013a). This undermines a solely syntactic theory, which rules out all instances of voice mismatch. These existence of these mismatches could support a view under which the identity is semantic. However, neither a completely syntactic nor a completely semantic theory would capture these mismatches; syntactic theories allow no mismatches, but semantic theories would permit all mismatches. Given this, it seems plausible to consider that the requirements are in part syntactic, and in part semantic, i.e., a hybrid approach. This is surely a possibility and this more nuanced possibility, as mentioned, casts doubt on theories which use the nature of the antecedent to implicate the nature of the antecedent.

A different way to construe the penalties incurred by voice mismatches in ellipsis is to appeal to a semantic account as opposed to a syntactic one. Effects taken to illustrate syntactic mismatches could be penalties incurred by an infelicitous discourse. A semantic theory alone allows all mismatches, but if constrained by discourse coherence, would permit both grammatical and ungrammatical mismatches. Kehler (2000) caches out such a theory. There are allowable mismatches under ellipsis, but only in the case that the correct discourse structure is maintained. Kehler (2000) distinguishes Cause-Effect discourse from Resemblance discourse relations. Only under a Cause-Effect relation are mismatches permitted. This follows from the fact that some syntactic representation is present for Resemblance relations, but not for Cause-Effect. When syntax is present, mismatches are infelicitous following the logic of syntactic identity not holding between antecedent and ellipsis site. When there is no syntax, then, mismatches are

possible. However, Frazier and Clifton Jr (2006) find that regardless of the causal relation, mismatches are ungrammatical, *contra* this more fine-grained, syntactic-semantic theory. Again, the results are equivocal.

The relations between clauses constitute one relation in a discourse, but it is worth considering the discourse beyond what holds between clauses, i.e., the information structure of the entire discourse above the clause level. (Kertz, 2013) investigates this claim. Even with differences in information structure controlled, there remains a cost. (Kertz, 2013) concludes that the ungrammaticality of the mismatches are not due to the information structure alone; the residual cost could be due to the syntactic mismatch.

Other mismatches between antecedent and ellipsis site have also been used to argue for a syntactic representation at ellipsis sites. Structural differences between the antecedent and ellipsis site derive gradient effects. The more structurally different the antecedent, the higher the processing cost incurred (Arregui et al. (2006); Kim et al. (2011)). For example, in Verb Phrase Ellipsis, a verb phrase constitutes a useable antecedent. The examples below illustrate VPE where there is an available verb phrase, but the availability of this verb phrase differs. These verb phrase antecedents are denoted by square brackets.

(10) Bill didn't [see the stars], but John did <see the stars>.

(11) [Seeing the stars] was hard, but John did <see the stars>.

This processing cost correlates with the number of 'derivational steps' it takes to access a useable verb phrase. There is no difficulty in (10), as there is a useable verb phrase *see the stars*. Difficulty *is* incurred in (11), where the verb phrase his contained within a gerund. While there is a verb phrase, it must be retrieved from within this structure—an additional step. If the representation of the antecedent were semantic, these structural difference would not be encoded. Only the representation of the verb phrase common to both *see the stars* is encoded. Under a semantic account, there should be no difference between the resolution of these ellipsis sites given different structures

at the antecedent. Thus, this provides an argument for the syntactic nature of the ellipsis site. Again, this relies on a one-to-one correspondence between the nature of the representation of the antecedent and ellipsis site. This reasoning was previously questioned, and the same arguments apply here, too.

To sum up: the experimental literature on ellipsis does not necessarily provide a clear, and direct, answer to the Ellipsis Site Question. In some cases, these investigations offer results about the antecedent, in some cases the relation between the antecedent and ellipsis site, but there are only indirect arguments made for the nature of the ellipsis site itself. Without a clear answer to the relation that must hold, it is tenuous to proceed in characterizing the ellipsis site based on the nature of the antecedent. Further, these indirect arguments are complicated by divergent results, which leaves the resulting picture even murkier.

One study which directly assesses the ellipsis site makes use of priming. In Xiang et al. (2014), syntactic priming is used to diagnose the presence of structure at the ellipsis site. If ellipsis sites induce priming effects, the ellipsis site must include syntactic structure. Only in the case that that structure is parsed is that structure primed. Xiang et al. (2014) find that ellipsis sites *do* induce syntactic priming. The upshot of this experiment , as opposed to those reviewed above, is that it relies directly on the properties of the syntax at the ellipsis site, not on an indirect argument.

In a similar way, the present study aims to also directly assess the ellipsis site, perhaps even more directly so than via priming. A point to take from Xiang et al. (2014) is that the ability for an ellipsis site to provide a prime suggests that there is reactivation in real-time. Theoretically, there is a distinction between if the ellipsis site contains syntactic structure, or merely a semantic representation. Experimentally, this same distinction can be considered in terms of the nature (syntactic or semantic) of the representation that is reactivated at the ellipsis site. The following section re-frames the discussion presented here in psycholinguistic terms of reactivation.

2.3 Extending Reactivation to Ellipsis

A rich literature in experimental linguistics concerns how structures are processed in real-time, specifically, the mechanisms by which structure is stored, maintained, and accessed. These questions arise when considering dependencies that are formed between pieces of structure. A dependency is a general term that characterizes a relation that must hold between two pieces of structure which are non-adjacent. Given this non-adjacency, there is temporal distance between elements, such dependancies give a window into this maintenance. More to the point, though, is how the access, or re-access, occurs.

Two kinds of dependencies have received the majority of attention: 1. dependencies created when constituents are displaced and 2. dependencies created when constituents are understood via reference to another constituent.
Dependencies of the displacement type are given below:

(12) Who$_i$ did you see $\_\__i$?

(13) I saw the man who$_i$ Jenna likes $\_\__i$.

In both examples there is a piece of structure that has been displaced. (12) is a question and the displaced element is the WH-phrase *who*. *Who* is understood as the object of the verb SEE, as indicated by the underscore following the verb that is indexed with WHO. It is understood in this position, but appears sentence initially, i.e., it is displaced. The case is the same for the relative clause in (**??**). The relative pronoun *who* has similarly been displaced, though is understood as the object of the verb *like*. The dependency that holds is between the displaced WH-phrase or relative pronoun and the empty, co-indexed position. When the position of the displaced constituent is encountered, i.e., the underscored positions, the co-indexed element is reactivated. Reactivation is taken to mean that the representation is available not only at the position where the overt element occurs, but also at the co-indexed position where it is not overt.

Another kind of dependency is created when constituents are understood via reference to another piece of structure.

(14) Jenna$_i$ saw Bob yesterday when she$_i$ was going to the store.

In (14), the pronoun *she* refers to *Jenna*; this pronoun requires an antecedent so that it may be understood.

A concrete example of reactivation comes from priming studies involving pronouns and their antecedents. Priming studies exploit the fact that participants will react more quickly when encountering elements which have been more recently activated. Take for example evidence given in Corbett & Chang (1983). An example from the experiment is given below.

(15) Jack threw a snowball at Phil, but he missed

Utilizing a probe at the position of the pronoun, *he*, participants are asked to choose between possible antecedents. Responses are faster for the referent with which the pronoun refers. This is because the information about the pronoun's antecedent becomes available when encountering the pronoun. Note that here, either name is a possible antecedent for the pronoun here, and as such, both facilitate faster responses following the pronoun. The point, though, is that pronouns trigger reactivation.

Reactivation has also been illustrated for the displacement type dependencies. Take for example relative clauses. In this construction, there is both a displacement dependency and an antecedent dependency. The relative pronoun must be associated to it's empty, co-indexed position as well as linked to the element to which it refers. Consider the example below.

(16) I saw the tie$_i$ that$_i$ was on the hanger __$_i$.

Here, the relative pronoun *that* forms a displacement dependency with the position following *hanger* and also refers to *the tie*. When the empty position is encountered, experimental results have illustrated that there is semantic priming (Love & Swinney,

1996). Semantic priming occurs when a lexical item activates its semantic neighbors. For example, *tie* may reactivate *clothing*, as they are semantically related. In this task, after encountering the empty position, participants must choose between a word and non-word appearing on screen. When the word that appears is semantically related to the displaced element co-indexed with the empty position, responses times are decreased compared to unrelated words. This is because the representation of the displaced element is reactivated at this point, i.e., the properties of the full representation are available at this position, generating priming effects.

A dependency is also instantiated by ellipsis. Interestingly, ellipsis has properties of both the displacement and antecedent type dependencies. Like displacement dependencies, ellipsis involves a relation between some piece of structure and some element of silence, though, there is nothing that is displaced. Like antecedent dependencies, ellipsis requires an antecedent. However, again, ellipsis is unique from the antecedent dependency in the example in that the relation holds between a piece of structure and silence, rather than two pieces of structure. Thus, ellipsis is a unique kind of dependency. Give its similarity to these dependencies, it is worth pursuing that ellipsis also involves reactivation of its antecedent at the position of silence.

In fact, there are theories of ellipsis which predict that there should be reactivation at sites of ellipsis. For example, with either the content-adressable pointer mechanisms or the cost-free copy-α mechanism, Experimental work has investigated this and has found that indeed, ellipsis sites do reactivate their antecedents (Xiang et al. (2014); Lau, Stroud, Plesch, and Phillips (2006); Poirier, Wolfinger, Spellman, and Shapiro (2010)). For example, semantic priming studies have illustrated that priming effects are found post-ellipsis, much like the semantic priming effects observed for other dependencies.

Taking it to be true that there is reactivation, a more narrow question can be posed, in fact, the question at the core of the present investigation: what is the nature of that reactivated representation? Recall that the theoretical literature diverges as to whether the ellipsis site contains full, syntactic structure or only semantic structure. This can

be asked in terms of reactivation: does the reactivated representation contain full, syntactic structure or only semantic structure? With this in hand, the last piece needed for the present investigation is a mechanism by which these representations could be distinguished.

2.4 Agreement Attraction

A mechanism is needed to assess the representation that is reactivated at ellipsis sites; agreement attraction provides such a diagnostic. First, the background on attraction is overviewed. Then, why it makes a useful probe is considered.

Agreement attraction errors have been noted by both theoretical syntacticians and grammarians alike (Jespersen (1924); Kimball and Aissen (1971); Dikken (2001)). This phenomenon is characterized by an agreement bearing element, here the verb, failing to match in features, here number, with the grammatical controller of agreement, (17).

(17) [The key to [the cabinets]$_{\text{PL}}$]$_{\text{SG}}$ were$_{\text{PL}}$ on the table.

The complex noun phrase controlling agreement *the key to the cabinets*, called the container, is singular. Singular agreement should appear on the verb (*was*), as the container controls agreement. However, in (17), the verb *be* shows plural agreement, (*were*). This is due to intervening plural, number features on the attractor noun, *the keys*, within the complex, container noun phrase.

Accounts of agreement attraction have appealed to the fact that the container noun and the attractor noun have different number features. The two predominant accounts differ as to how the plural features of the attractor noun are realized on the verb: one account employs a syntactic mechanism and the other appeals to errors made under the pressure of real-time processing constraints.

The syntactic analysis posits that the plural features of the attractor noun percolate upward to the head noun (Eberhard, Cutting, and Bock (2005); Franck, Vigliocco, and Nicol (2002); Vigliocco and Nicol (1998)). The head contains both singular and plural

features. The agreement mechanism is able to access either of the feature sets present on the head noun. Standard agreement occurs when the singular features of the head are used for agreement and attraction arises when agreement is constructed based on the plural features that have percolated. Under this account, it is the location of the features that derives the agreement attraction. Nothing changes about the mechanism that determines how agreement occurs; it is the representation of the features on the head noun that is inconsistent.

The second account appeals to processing; there is no movement of the crucial plural features that trigger attraction. The complex noun phrase is singular, and the noun contained within it is plural; the head noun does not take on the plural features of the noun within it. Rather, when under real-time processing constraints while constructing an agreement relation, the incorrect noun phrase can be selected for agreement. Attraction arises due to an error made when selecting the controller of agreement, as a reflection of the effects of similarity-based interference under a system of cue-based retrieval (Lewis & Vasishth, 2005).

On the syntactic account, the representation of the number features is faulty, and on the processing account, it is the access mechanism that is faulty. While the syntactic account posits an inconsistency in how the features are represented, the processing account reflects no such inconsistency in the representation of the structure, but an inconsistency in how the noun phrases are accessed in real-time when multiple constituents in the structure are active.

Stepping back to the larger picture, studies focusing on production have illustrated that there are various factors that have an impact on the likelihood for attraction, including the number features of the attractor, structural distance from the grammatical controller, and linear order (Bock and Cutting (1992); Bock and Eberhard (1993); Bock and Miller (1991)). Here, AA's sensitivity to morpho-syntactic number features, as opposed to semantic or conceptual number, is what makes AA an ideal probe. How this sensitivity relates to diagnosing representations in ellipsis is explored in §3.

3 Experimental Studies

The present study is comprised of four experiments that aim to more directly assess the nature of the representation reactivated at ellipsis sites. There are, in fact, two questions which are of primary interest: What is the nature of the reactivated representation (i.e., syntactic or semantic) and how much of the reactivation is reactivated at sites of ellipsis? This is done by combining the ellipsis construction Noun Phrase Ellipsis (NPE), which elides nominals, with attraction-triggering nominals.

First, it is necessary to introduce the ellipsis construction that will be utilized for the present investigation. It is by no accident that the literature review in previous sections focused exclusively on Verb Phrase Ellipsis (VPE). Investigations of ellipsis have primarily focused on VPE. In fact, in the theoretical literature there is less work that has investigated NPE (LaCara (2010); Chisholm (2002)), and fewer still regarding the processing of NPE (Lau et al., 2006). The choice to use NPE is for two reasons: it offers a window into another elliptical construction and the construction allows for more control over what occurs in the ellipsis site; NPE elides a nominal. This latter point become important when combining the NPE construction with the attraction-triggering nominals, which should diagnose the nature of the ellipsis site.
Returning to NPE: as stated, NPE elides a nominal, as seen in (15).

(18) I walked John's dog and Mary walked Sue's <dog>.

The possessive structure is one configuration where NPE is licensed. The nominals that follows the possessor *'s* can go missing under identity, as is the case with other ellipsis constructions. Taking a detour outside of ellipsis, consider the examples below which illustrate that the it is the head noun contained within the possessive structure that controls agreement on the verb following the possessive structure. This will become important when considering the interaction of attraction-triggering nominals and NPE.

(19) John's key was on the table.

(20) John's keys were on the table.

In (19) and (20), in both cases it is the number features on the head noun of the possessive structure, here *key* and *keys*, respectively, that controls agreement. Returning to ellipsis, (21) and (22) mirror the example above, but here, the head noun has been elided, yet it is still the head noun that controls agreement.

(21) John's key got lost but Joe's was on the floor.

(22) John's keys got lost but Joe's were on the floor.

So, what NPE provides is a structure where material contained in the ellipsis site, here the relevant features needed to construct agreement, are elided, yet still interact with material outside of the ellipsis site. This interaction between elided material and overt structure provides a very direct probe of the ellipsis site. By placing attraction-triggering nominals in a context where they can be elided, their properties can be used to inform the nature of the representation and how much of that representation is re-activated.

Attraction nominals are of importance because they contain two sets of features. Further, in being nominals, they are able to be elided by NPE. Consider the example below, which places the attraction-triggering nominal in a position where it can serve as the antecedent for an NPE ellipsis site.

(23) Scarlett's [key to the cabinets] got lost, but
Chelsea's $< >$ was/were on the table.

Now, the potentially reactivated representation of the attraction-triggering nominal controls agreement in the elided clause. Outside ellipsis, these nominals trigger attraction, and now the potential for it's reactivated representation to trigger attraction will be examined. Recall that attraction effects are derived by a sensitivity to morpho-syntactic number features, but not semantic or conceptual number. When the attraction-triggering nominal is reactivated at the ellipsis site, its ability to trigger

attraction, or not, diagnoses the representation. If attraction occurs, this implicates a syntactic representation at ellipsis sites. This follows from the fact that only a syntactic representation would encode morpho-syntactic number features, whereas a semantic representation would not.

Additionally, using these complex nominals allows for the question of the size of the reactivated constituent to be examined. If the entire structure is reactivated, the plural features will be as well, which could trigger attraction. If only the head were reactivated, and as such no plural number features, attraction is not predicted. Thus, the agreement that appears on the verb can diagnose the size of the reactivated constituent; this is schematized in (21).

(24) Scarlett's [key to the cabinets] got lost, but . . .

a. Chelsea's <key> was on the table. *Partial Reactivation*

b. Chelsea's <key to the cabinets> were on the table. *Full Reactivation*

Roadmap of Experiments

The experiments presented here examine reactivated representations through the use of attraction. Experiment 1 provides a baseline; when attraction-triggering nominals are placed in a possessive structure, but not elided, will they generate attraction? Attraction effects were found. In Experiments 2 & 3, the same nominals were used as antecedents for ellipsis and the relation between the antecedent and ellipsis site is varied. No local attraction effects were found, however, long-distance attraction occurs in Experiment 2. The claim pursued is that the reactivation at ellipsis sites is only partial—only features of the *head* are reactivated. Experiment 4 tests this claim: when only the attractor, a head, is elided, do attraction effects arise? Yes. This quartet of experiments illustrates that the nature of the reactivated representation at ellipsis sites is syntactic and that the full structure is not reactivated.

3.1 Experiment 1

The first experiment examines if agreement attraction can occur when attraction-triggering nominals are housed within a possessive structure, e.g., *John's key to the cabinets*. This experiment serves as a baseline for the experiments to follow where these nominals are elided. To assure that the complex nominals under ellipsis can generate attraction effects, it must first be illustrated that these nominals give rise to attraction effects outside of ellipsis.

3.1.1 Participants

Participants were 64 individuals recruited on MechanicalTurk. All participants in this and the following experiments provided their informed consent. Participants were compensated $8.50/h. No participant took part in more than one of the experiments.

3.1.2 Materials

The experiment employed a 2x2 design crossing the factors of the number of the ATTRACTOR (Singular (SG)/Plural (PL)) and the GRAMMATICALITY of the agreeing verb (Grammatical (G)/Ungrammatical (UG)). 32 sets were constructed and items were distributed via a Latin Square over 32 lists. Each list was combined with 64 fillers for a total of 96 items per participant. An example set is given in Table 1. Full materials are given in Appendix A. The first six words followed the template *Name's–noun–preposition–determiner–noun–verb*. The agreeing verb was either the auxiliary or copular BE. Locative and temporal prepositional phrases followed the agreeing verb. These constituted the spill over region, which is where effects of agreement attraction are predicted to occur.

Table 1: Example item set for Experiment 1

GRAM.	ATTR.	
G	SG	John's memo from the architect$_{SG}$ was$_{G}$ on the table.
G	PL	John's memo from the architects$_{PL}$ was$_{G}$ on the table.
UG	SG	John's memo from the architect$_{SG}$ were$_{U}$ on the table.
UG	PL	John's memo from the architects$_{PL}$ were$_{U}$ on the table.

The experimental items were counterbalanced to include simple nouns and derived nouns as the head of the attraction-triggering nominal. This counterbalance addresses an issue which will become relevant within following experiments where these nominals are elided. See the discussion in §3.2.2 which motivates this counterbalance. At present, both are included to assure that regardless of the head type of the nominal, these nominals *do* give rise to agreement attraction.

3.1.3 Predictions

Prior experimental investigations of agreement attraction have revealed that there is a signature pattern that denotes attraction: the attraction condition (plural attractor, ungrammatical verb) patterns like the grammatical conditions, to the exclusion of the fully ungrammatical (singular attractor, ungrammatical verb). Thus, the signature of agreement attraction is the interaction of ATTRACTOR with GRAMMATICALITY: the ungrammatical condition with a plural attractor should be read more quickly than the ungrammatical condition with a singular attractor. If attraction is present within the experiment, it is expected to exhibit this same pattern.

3.1.4 Procedure

Sentences were presented online using the Ibex online interface. A self-paced word-by-word moving window paradigm was used (Just, Carpenter, & Woolley, 1982). Each trial began with a screen presenting a sentence where the words were masked and in their place were dashes. To complete the trial, the participant would press the space-bar to advance the sentence. With each press, one word would be revealed, and the

previous word masked, so that the words of the sentence were presented one by one. A yes/no comprehension question followed each item. Participants could respond by clicking on the correct answer or using the '1' key for 'yes' and the '2' key for 'no'. Feedback was provided on screen for incorrect answers. Participants were instructed to read at a normal pace and answer the questions to the best of their ability.

A practice phase preceded the experimental trial. This included 3 example sentences introducing the word-by-word moving window paradigm followed by 3 practice items with comprehension questions for familiarization with the mechanics of the task.

3.1.5 Analysis

The analysis consisted of fitting a linear mixed-effect model. The factors of the experimental design were included as fixed effects and random effects were included for participants and items. The full random effect structure for participants was supported by the data but only random intercepts were fit for items.

The data were trimmed prior to analysis based on reaction times and accuracy. Reaction times more than 2.5 standard deviations from the mean were removed. Only questions for which the comprehension question was answer correctly were included in the analysis. To assess potential differences stemming from the head noun counterbalance, the data were subset and models were fitted separately for each subset.

3.1.6 Results

The reading time results from Experiment 1 are presented in Figures 1–2 and Tables 2–5. The regions for analysis included the verb and the three following regions, i.e., words, (V+1, V+2, and V+3).

At the Verb, there were no significant effects. At the V+1 region, there were main effects for both ATTRACTOR and GRAMMATICALITY and an interaction of ATTRACTOR with GRAMMATICALITY. Conditions with plural attractors were read more quickly

than those with singular attractors. Grammatical conditions were read faster than ungrammatical conditions. This generated an interaction: ungrammatical conditions with plural attractors were read faster than ungrammatical conditions with singular attractors. In the V+2 region, the main effect of GRAMMATICALITY persisted; ungrammatical conditions were read more slowly. There were no significant effects in the V+3 region.

Table 2: Mixed-effect model coefficient table for Experiment 1.
Bold values indicate statistical significance.

		β	SE	t	p	
Verb						
	Attractor	19.46	12.50	1.55	0.12	
	Grammaticality	10.21	10.03	1.01	0.31	
	Attractor × Grammaticality	-4.22	18.43	-0.22	0.81	
V + 1						
	Attractor	**-30.07**	**9.69**	**-3.10**	**0.002**	**
	Grammaticality	**47.48**	**11.88**	**3.99**	**0.0001**	***
	Attractor × Grammaticality	**-44.55**	**21.45**	**-2.07**	**0.04**	*
V + 2						
	Attractor	0.68	8.87	0.07	0.93	
	Grammaticality	**28.30**	**8.24**	**3.43**	**0.0007**	***
	Attractor × Grammaticality	-15.17	17.01	-0.89	0.37	

Table 3: Means for Experiment 1 by region.

GRAM.	ATTR.	V	V+1	V+2	V+3
G	SG	342	346	335	317
G	PL	358	335	334	313
UG	SG	352	415	366	320
UG	PL	365	361	354	317

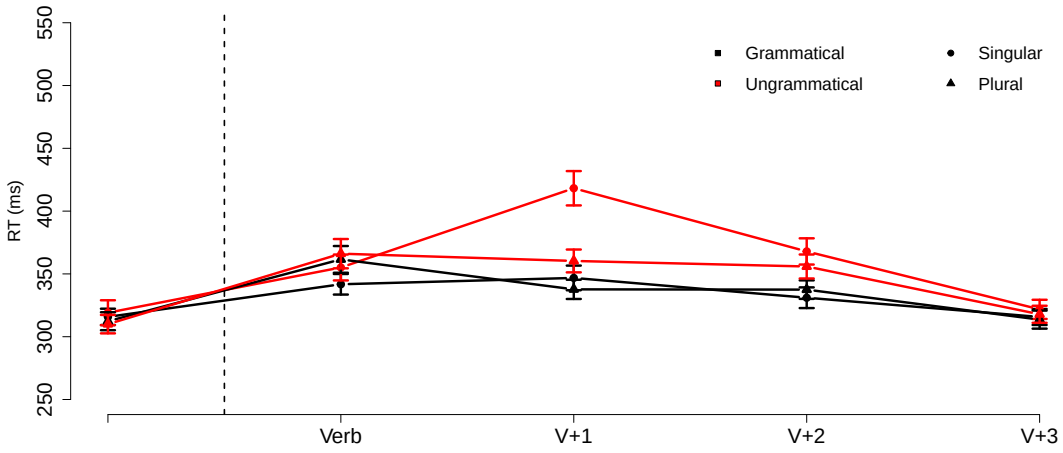


Figure 1: Self-paced reading results of Experiment 1. Region by region means by ATTRACTOR and GRAMMATICALITY. Error bars indicate standard error of the mean.
Sample: . . . *was/were*$_{\text{Verb}}$ *on*$_{\text{V+1}}$ *the*$_{\text{V+2}}$ *table*$_{\text{V+3}}$

The data reported below are based on models constructed based on the data after it was subset into two data sets by the head noun type counterbalance.

Derived Nouns

At the verb, there were no significant effects. At the V+1 region, there was a main effect of ATTRACTOR. Plural attractor conditions were read more quickly than singular attractor conditions. There was also a main effect of GRAMMATICALITY; ungrammatical conditions were read more slowly. The GRAMMATICALITY effect persisted in the V+2 region. There were no significant effects in the V+3 region.

Simple Nouns

At the verb, there were no significant effects. At the V+1 region, there was a main effect of GRAMMATICALITY which persisted in the V+2 region; the ungrammatical condition was read more slowly than the grammatical condition. There were no significant effects in the V+3 region.

Table 4: Mixed-effect model coefficient table for Experiment 1, subset by Head Type (Derived/Simple). Bold values indicate statistical significance.

		DERIVED					SIMPLE				
		β	SE	t	p		β	SE	t	p	
Verb											
	Attr.	15.17	16.70	0.90	0.36		1.05	4.67	0.22	0.82	
	Gram.	4.70	16.01	0.29	0.76		1.77	3.74	0.47	0.63	
	A×G	-37.31	30.15	-1.23	0.21		-4.76	6.91	-0.69	0.49	
V + 1											
	Attr.	**-62.11**	**19.44**	**-3.19**	**0.001**	**	-7.55	10.15	-0.74	0.45	
	Gram.	**66.24**	**19.52**	**3.39**	**0.0009**	***	**32.71**	**12.81**	**2.55**	**0.01**	*
	A×G	-59.44	40.33	-1.47	0.15		-26.40	22.71	-1.16	0.24	
V + 2											
	Attr.	-2.78	13.89	0.20	0.84		-1.78	11.42	-0.15	0.87	
	Gram.	**33.68**	**14.42**	**2.33**	**0.02**	*	**23.18**	**10.17**	**2.28**	**0.02**	*
	A×G	-19.33	28.75	-0.67	0.51		-10.72	20.64	-0.51	0.61	

Table 5: Means for Experiment 1 by region, subset by Head Type (Derived/Simple).

		DERIVED				SIMPLE			
Attr.	Gramm.	V	V+1	V+2	V+3	V	V+1	V+2	V+3
G	SG	342	368	314	307	342	336	340	320
G	PL	375	335	326	305	352	339	346	320
UG	SG	359	463	366	306	353	386	369	333
UG	PL	362	375	356	321	369	351	356	316

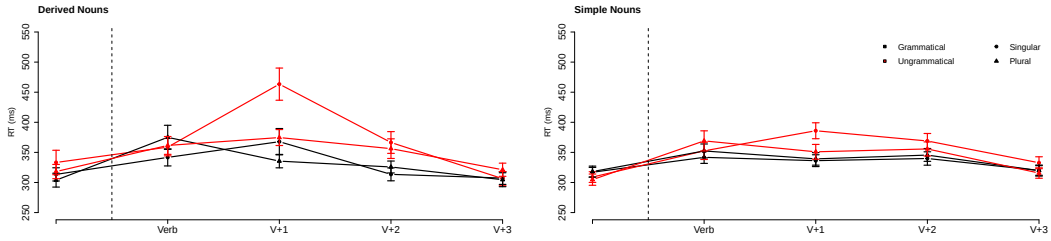


Figure 2: Self-paced reading results of Experiment 1, subset by Head Type: Derived (Left), Simple (Right). Region by region means by ATTRACTOR and GRAMMATICALITY. Error bars indicate standard error of the mean.
Sample: . . . *was/were*$_{\text{Verb}}$ *on*$_{\text{V+1}}$ *the*$_{\text{V+2}}$ *table*$_{\text{V+3}}$

3.1.7 Discussion

The significant effects for Experiment 1 arose in the V+1 region. Most notably is the interaction of ATTRACTOR by GRAMMATICALITY, which is the signature of the agreement attraction pattern. First, the main effects will be discussed. The main effect of GRAMMATICALITY indicates that there was sensitivity to the mismatch in number features between the head noun and the agreeing verb. The main effect of ATTRACTOR indicates the possibility of attraction. Regardless of the grammaticality of the following verb, the plural attractors decreased reading times. In the ungrammatical condition with a plural attractor, this follows from the possibility of attraction. Why the grammatical condition with a plural attractor should also pattern this way is less straightforward. This effect could be a reflection of the asymmetry that arises in attraction; there is decreased effort for sentences with attraction, but no penalty for sentences which fail to attract. For the plural attractor conditions, the features of the head noun and the features of the attractor are available—both singular features and plural features. Then, when making a prediction about the following form of the verb, either the ungrammatical or grammatical verb may be expected, since both features are available. No slow down is predicted, as either is possible. The interaction of these main effects derives the pattern of the ungrammatical, plural condition (the crucial, agreement attraction condition), patterning like the grammatical conditions, to the exclusion of the fully ungrammatical condition (singular attractor, ungrammatical verb). Though there is a cost for ungrammaticality, the speed up for plural conditions decreases the overall reading time for the agreement attraction condition.

The persisting effect of GRAMMATICALITY in V+2 indicates continued sensitivity to the mismatch in number features between the singular head noun, and the ungrammatical, plural agreement on the verb.

Derived Nouns vs. Simple Nouns

The analysis of the subsetted data suggests that the attraction effect is driven by a subset of the head nouns; the derived nouns generate stronger effects. This difference can

be explained by appealing to the effects of processing structures of differing complexity. For the simple nouns, there is a head noun with either an argument or adjunct. In the case of the derived noun, there is potentially more structure present which 'wraps' the verbal component in a nominal projection; derived nominals are more complex structure than nominals. This additional structure could result in longer reading times, as it takes longer to process a more complex structure. This follows from the reading time data. Prior to the regions of analysis, when the head noun is encountered, derived nouns are read more slowly than simple nouns. Further, within the regions of analysis, these slower reading times persist for the derived noun subset.

Depth of processing effects can be used to explain why the derived nouns are driving the effects seen. When a structure incurs greater processing cost (this cost being inferred from increased reading time), this structure will then be processed more deeply, i.e., more strongly encoded in memory, higher activation, etc. Since the derived nominal is more complex and takes additional time to read, it could have been processed more deeply, thus more strongly encoding the relevant features. The more robust features then derive more robust attraction effects.

This experiment provides the first step in assessing the nature of the representation reactivated at ellipsis sites. As noted, there are several factors to which attraction is sensitive, one being the structural distance of the attractor from the agreeing verb. Despite this increase in distance due to the attraction-triggering nominal being housed in a possessive structure, attraction effects *do* significantly emerge. Further, there is a novel result that derived nouns generate more robust attraction effects than simple nouns.

3.2 Experiment 2

The second experiment examines attraction-triggering nominals when elided. In Experiment 1, attraction-triggering nominals within a possessive structure gave rise to agreement attraction effects. Here, these same nominals are used as the antecedents for Noun Phrase Ellipsis to see if agreement attraction occurs in the post-elliptical region. The occurrence of attraction effects would diagnose the ellipsis site as being syntactic in nature and that the size of the reactivated representation is the entire attraction-triggering nominal. Conversely, the lack of attraction effects would indicate that the representation is NOT reactivated in full. If effects of grammaticality still arise with partial reactivation, this would still implicate the presence of syntactic structure at the ellipsis site. If not, this would suggest a representation devoid of syntax.

3.2.1 Participants

Participants were 64 individuals recruited on MechanicalTurk; they were compensated $8.50/h

3.2.2 Materials

The experiment employed a 2x2x2 design crossing the factors of the number of the ATTRACTOR (Singular (SG)/Plural (PL)), the GRAMMATICALITY of the agreeing verb (Grammatical (G)/Ungrammatical (UG)), and ELLIPSIS (No Ellipsis/Ellipsis). 32 sets were constructed and items were distributed via a Latin Square over 32 lists. Each list was combined with 64 fillers for a total of 96 items per participant. An example set is given in Table 6. Full materials are given in Appendix B.

Each item included two clauses. The first served as the antecedent clause and contained an attraction-triggering nominal. The second provided the ellipsis site. Clauses were joined by connectives such as *because, during, while*. The first seven words in the first clause followed the template of *Name's–noun–preposition–determiner–noun–verb–*

verb. The agreeing verb in the first clause never showed morphological differences between the singular and plural forms. The second clause followed the template *Name–Adverb–be–predicate*. The agreeing verb was either the auxiliary or copular BE. In the ellipsis condition, the name was followed by a possessor, licensing ellipsis. This allowed the elliptical and non-elliptical conditions to differ as minimally as possible; possessor aside, the structures were identical. The adverb was included preceding the agreeing verb to allow for the time that may be necessary for reactivation to occur.

Table 6: Example item set for Experiment 2.

No Ellipsis	GRAM.	ATTR.	
	G	SG	Elise's memo from the supervisor$_{SG}$ got lost while Audrey conveniently was$_{G}$ at the office.
	G	PL	Elise's memo from the supervisors$_{PL}$ got lost while Audrey conveniently was$_{G}$ at the office.
	UG	SG	Elise's memo from the supervisor$_{SG}$ got lost while Audrey conveniently were$_{U}$ at the office.
	UG	PL	Elise's memo from the supervisors$_{PL}$ got lost while Audrey conveniently were$_{U}$ at the office.
Ellipsis	GRAM.	ATTR.	
	G	SG	Elise's memo from the supervisor$_{SG}$ got lost while Audrey's conveniently was$_{G}$ at the office.
	G	PL	Elise's memo from the supervisors$_{PL}$ got lost while Audrey's conveniently was$_{G}$ at the office.
	UG	SG	Elise's memo from the supervisor$_{SG}$ got lost while Audrey's conveniently were$_{U}$ at the office.
	UG	PL	Elise's memo from the supervisors$_{PL}$ got lost while Audrey's conveniently were$_{U}$ at the office.

The first experiment employed a counterbalance for the type of noun that headed the attraction-triggering nominal: simple nouns (25) and derived nouns (26). These same nominals were used, with the same counterbalance in place, in the last experiment (Experiment 1), the present experiment (Experiment 2), and those following (Experiments 3 & 4).

(25) John's **memo** from the supervisors were on the table.

(26) John's **happiness** for the employees were apparent.

The purpose of this counterbalance is to assure that if agreement attraction effects arise,

they can be attributed to the number features of the intervening noun. NPE elides a noun phrase, but there is no way to assure that the entirety of the complex noun phrase is used as the antecedent. It could be the case that only the head NP is used. This would give rise to the above sentences being understood under ellipsis as the following, the angled brackets representing elided material ((22) serves as the antecedent for (24), and (23) for (25)):

(27) Bill's <memo> were, too.

(28) Bill's <happiness> were, too.

Here, only the head constitutes the antecedent, and there is a mismatch between the singular features of the head noun and the plural features that appear on the verb following. While it is possible that only the head is selected as the antecedent, prior work on Verb Phrase Ellipsis (VPE) suggests that the largest antecedent possible is chosen, i.e., MAXELIDE (Merchant, 2013b). However, for previous cases, what MAXELIDE captures is that nodes *higher* in the structure should be selected, e.g., taking the maximal amount of the verbal domain. Regardless of height of the node, *all* structure dominated by that node constitutes the antecedent. In construing the ellipsis site to be only the head, a different portion of the structure would not be included, namely, structure that is dominated by whatever the maximal head is selected as the antecedent, not the lack of inclusion of higher, dominating nodes. If NPE behaves like VPE, we expect the maximal portion of the nominal domain to be elided, but not that nodes dominated by the maximal eliding head would not be included. However, if this is permitted, the issue of allowable mismatches tolerated under ellipsis warrants consideration.

Under ellipsis, there are cases in which certain changes are permitted, and perhaps one of these changes is in number. In order to resolve the mismatch in features of the grammatical controller (singular) and features on the verb (plural), the head noun could be construed as plural. This would not illustrate reactivation of the structure in its entirety as giving rise to attraction, but instead an allowable mismatch under

NPE. However, the derived nominals can *not* be construed as being plural; note the ungrammaticality of (30) below.

(29) John's **memos** were on the table.

(30) John's ***happinesses** were apparent.

This counterbalance allows for agreement attraction effects, if present, to be attributed to the intervening number features that are reactivated within the complex nominal as opposed to a reinterpretation strategy that permits number mismatches under NPE.

3.2.3 Procedure & Analysis

The same self-paced reading procedure was used as in Experiments 1. The analysis conducted was the same; mixed-effects linear regressions were fit to the data. Further analysis split the data by the factor of ELLIPSIS, as well as by the counterbalance, as was done in Experiment 1.

3.2.4 Results

The reading time results from Experiment 2 are presented in Figures 3–4 and Tables 7-11. The regions for analysis included the verb and the three following regions, i.e., words, (V+1, V+2, and V+3).

At the verb, there were no significant effects. At V+1, there was a significant main effect of GRAMMATICALITY; ungrammatical conditions were read more slowly. There was a significant interaction of ATTRACTOR with GRAMMATICALITY; ungrammatical conditions with singular attractors are read more slowly than ungrammatical conditions with plural attractors. At V+2, there was a main effect of ATTRACTOR; conditions with plural attractors were read more quickly than those with singular attractors. The interaction of ATTRACTOR with GRAMMATICALITY returned in the V+3 region; ungrammatical conditions with plural attractors were read more quickly than those with singular attractors.

Table 7: Mixed-effect model coefficient table for Experiment 2.
Bold values indicate statistical significance.

		β	SE	t	p	
Verb						
	Attractor	-9.8462	9.3044	-1.058	0.293	
	Grammaticality	-0.4855	8.5292	-0.057	0.955	
	Ellipsis	-3.5022	8.1254	-0.431	0.667	
	Attractor × Grammaticality	-22.1987	17.6971	-1.254	0.213	
	Attractor × Ellipsis	-0.4385	16.2574	-0.027	0.978	
	Grammaticality × Ellipsis	-6.0492	16.2536	-0.372	0.71	
	Attractor × Grammaticality × Ellipsis	27.7067	32.6006	0.85	0.396	
V + 1						
	Attractor	-5.71	8.20	-0.69	0.48	
	Grammaticality	**30.19**	**9.92**	**3.04**	**0.003**	**
	Ellipsis	-3.96	7.62	-0.52	0.61	
	Attractor × Grammaticality	**-35.48**	**16.13**	**-2.19**	**0.03**	*
	Attractor × Ellipsis	4.03	15.24	0.26	0.79	
	Grammaticality × Ellipsis	-11.011	15.23	-0.72	0.469	
	Attractor × Grammaticality × Ellipsis	25.61	30.55	0.83	0.41	
V + 2						
	Attractor	**-20.74**	**9.92**	**-2.09**	**0.04**	*
	Grammaticality	5.67	10.41	0.54	0.58	
	Ellipsis	-14.96	8.74	-1.71	0.08	.
	Attractor × Grammaticality	-14.54	20.35	-0.71	0.47	
	Attractor × Ellipsis	19.16	17.48	1.09	0.27	
	Grammaticality × Ellipsis	-24.68	17.47	-1.41	0.15	
	Attractor × Grammaticality × Ellipsis	8.61	35.04	0.24	0.81	
V + 3						
	Attractor	-5.24	7.96	-0.65	0.51	
	Grammaticality	4.91	7.11	0.69	0.48	
	Ellipsis	0.11	7.11	0.01	0.98	
	Attractor × Grammaticality	**-29.91**	**14.88**	**-2.01**	**0.04**	*
	Attractor × Ellipsis	-13.15	14.22	-0.92	0.35	
	Grammaticality × Ellipsis	-4.96	14.22	-0.34	0.72	
	Attractor × Grammaticality × Ellipsis	18.74	28.51	0.65	0.51	

Table 8: Means for Experiment 2 by region.

ELLIPSIS	GRAM.	ATTR.	V	V+1	V+2	V+3
NE	G	SG	333	301	331	304
NE	G	PL	349	323	313	333
NE	UG	SG	352	358	352	328
NE	UG	PL	325	330	318	314
E	G	SG	336	304	314	314
E	G	PL	332	313	313	319
E	UG	SG	344	351	320	335
E	UG	PL	324	326	297	307

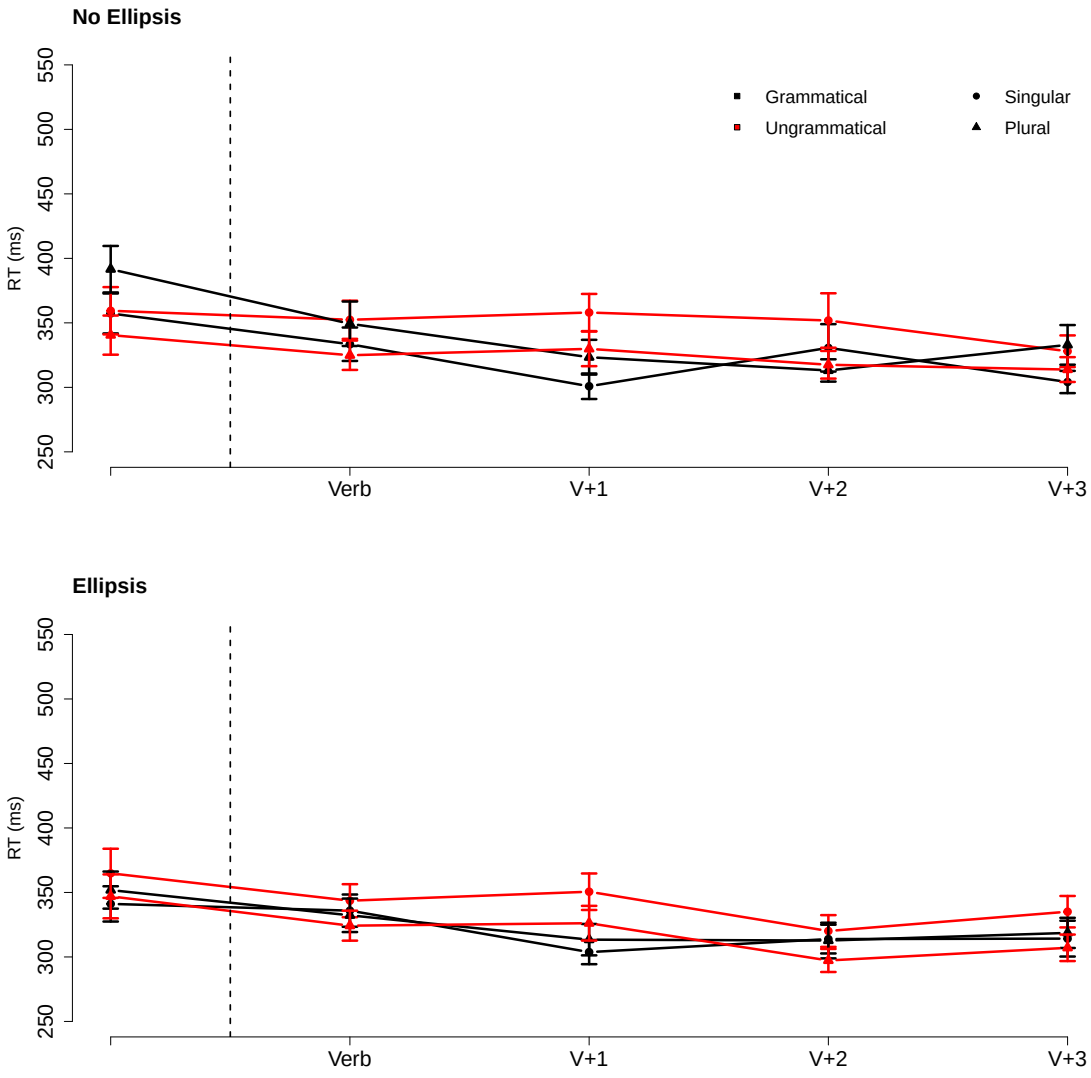


Figure 3: Self-paced reading results of Experiment 2. Region by region means by ATTRACTOR and GRAMMATICALITY. Error bars indicate standard error of the mean.
Sample: . . . *was/were*$_{Verb}$ *at*$_{V+1}$ *the*$_{V+2}$ *office*$_{V+3}$

In further analysis, the data were split based on the ELLIPSIS factor. In the full analysis given in Table 7, there were no approaching or significant interactions with ELLIPSIS. However, the design was such that agreement attraction should not be found in the NO ELLIPSIS condition. The data were split to isolate which condition was driving the attraction effect.

Ellipsis

There was a main effect of GRAMMATICALITY occurring at V+1; ungrammatical conditions were read more slowly.

No Ellipsis

There were no significant effects at the verb. At the V+1 region, both the main effect of GRAMMATICALITY and its interaction with ATTRACTOR, were significant. Ungrammatical conditions were read more slowly, but ungrammatical conditions with singular conditions were read more slowly than ungrammatical conditions with plural attractors. At V+2, the main effect of ATTRACTOR approached significance; conditions with plural attractors were read more quickly. At V+3, the interaction of ATTRACTOR with GRAMMATICALITY resurfaces; again, ungrammatical conditions with plural attractors were read more quickly.

Table 9: Mixed-effect model coefficient table for Experiment 2, split by ELLIPSIS factor. Bold values indicate statistical significance.

		ELLIPSIS					NO ELLIPSIS				
		β	SE	t	p		β	SE	t	p	
Verb											
	Attr.	-12.64	10.48	-1.21	0.22		-9.33	12.75	-0.73	0.46	
	Gram.	-0.011	10.45	-0.01	0.99		2.83	12.74	0.22	0.82	
	A×G	-5.16	21.03	-0.24	0.81		-36.55	25.48	-1.43	0.15	
V + 1											
	Attr.	-4.97	10.82	-0.46	0.64		-7.61	11.27	-0.67	0.49	
	Gram.	**25.29**	**10.81**	**2.34**	**0.01**	*	**37.22**	**11.26**	**3.31**	**0.001**	**
	A×G	-27.41	21.71	-1.26	0.21		**-45.27**	**22.51**	**-2.01**	**0.04**	*
V + 2											
	Attr.	-11.71	10.06	-1.16	0.24		-28.91	14.75	-1.95	0.05	.
	Gram.	-6.91	10.03	-0.68	0.49		15.88	14.74	1.07	0.28	
	A×G	-13.93	20.18	-0.69	0.49		-19.21	29.47	-0.65	0.51	
V + 3											
	Attr.	-11.17	10.32	-1.08	0.28		1.04	10.11	0.11	0.91	
	Gram.	2.77	10.31	0.26	0.78		6.83	10.09	0.67	0.49	
	A×G	-20.64	20.71	-0.99	0.31		**-39.67**	**20.17**	**-1.96**	**0.04**	*

The data reported below are based on models constructed based on the data after it was subset into two data sets by the head noun type counterbalance.

Derived Nouns

At the verb, the interaction of ATTRACTOR with GRAMMATICALITY approached significance; ungrammatical conditions with singular attractors were read more slowly than ungrammatical conditions with plural attractors. At V+1, this interaction persisted, though non-significantly, and with the same pattern. The main effect of GRAMMATICALITY was significant and the main effect of ATTRACTOR approached significance. Ungrammatical conditions were read more slowly and singular attractor conditions were read more slowly. At V+2, the interaction of GRAMMATICALITY and ELLIPSIS was significant; in the NO ELLIPSIS condition, ungrammatical conditions were read more slowly than grammatical conditions, but in ELLIPSIS, ungrammatical conditions were read more quickly. In the ELLIPSIS condition, the attraction condition was read the quickest, which may look like attraction, but the fully ungrammatical condition patterned like the grammatical conditions. At V+3, the interaction of ATTRACTOR and GRAMMATICALITY was significant; in the NO ELLIPSIS condition, the grammatical, plural attractor condition was read the slowest and in the ELLIPSIS condition, the ungrammatical, plural attractor condition was read the fastest.

Simple Nouns

At the verb, there were main effects of ATTRACTOR and ELLIPSIS; plural attractor conditions were read more quickly and the NO ELLIPSIS condition was read more slowly. There were several significant interactions: ATTRACTOR with GRAMMATICALITY, GRAMMATICALITY with ELLIPSIS, and a three-way interaction of ATTRACTOR with GRAMMATICALITY with ELLIPSIS. While the ATTRACTOR with GRAMMATICALITY can indicate agreement attraction, here, the condition which was read the slowest was the grammatical, plural attractor condition. For the GRAMMATICALITY with ELLIPSIS interaction, the ungrammatical conditions were read more slowly in the ELLIPSIS condition. For the three-way interaction, ungrammatical plural attractor conditions

were read more quickly than ungrammatical singular attractor conditions, but only in the ELLIPSIS condition. At V+1, there was a main effect of GRAMMATICALITY, ungrammatical conditions were read more slowly. At V+2, the main effect of ATTRACTOR approached significance. Conditions with plural attractors were read more quickly overall. The main effect of ELLIPSIS also approached significance; the NO ELLIPSIS condition was read more slowly than the ELLIPSIS condition.

Table 10: Mixed-effect model coefficient table for Experiment 2, subset by Head Type (Derived/Simple). Bold values indicate statistical significance.

		DERIVED					SIMPLE				
		β	SE	t	p		β	SE	t	p	
Verb											
	Attr.	-8.43	12.94	-0.65	0.52		**-5.96**	**2.95**	**-2.02**	**0.04**	*
	Gram.	23.29	12.28	1.89	0.07		-1.51	2.95	-0.51	0.61	
	Ell.	-8.34	12.17	-0.68	0.50		**-7.69**	**2.96**	**-2.59**	**0.009**	**
	A×G	**-91.83**	**26.23**	**-3.50**	**0.08**	**.**	**-11.63**	**5.89**	**-1.97**	**0.04**	*
	A×E	-29.05	24.06	-1.20	0.24		7.63	5.93	1.28	0.19	
	G×E	-52.15	24.60	-2.11	0.22		**16.91**	**5.94**	**2.84**	**0.004**	**
	A×G×E	-22.61	50.73	-0.44	0.66		**37.57**	**11.89**	**3.15**	**0.001**	**
V + 1											
	Attr.	**-25.11**	**13.60**	**-1.84**	**0.07**	·	2.35	9.33	0.25	0.80	
	Gram.	**49.76**	**13.47**	**3.69**	**< 0.00**	***	**27.6**	**9.34**	**2.95**	**< 0.01**	**
	Ell.	9.07	13.53	0.67	0.51		-9.24	9.37	-0.98	0.32	
	A×G	**-48.12**	**26.94**	**-1.78**	**0.08**	·	-27.53	18.66	-1.47	0.14	
	A×E	27.43	26.95	1.01	0.32		-11.49	18.75	-0.61	0.54	
	G×E	-46.18	27.06	-1.70	0.10		5.66	18.76	0.30	0.76	
	A×G×E	-15.15	53.83	-0.28	0.77		39.90	37.55	1.06	0.29	
V + 2											
	Attr.	-14.25	14.07	-1.01	0.32		**-20.83**	**10.65**	**-1.95**	**0.04**	*
	Gram.	10.23	13.55	0.75	0.45		4.34	10.66	0.40	0.68	
	Ell.	-7.53	13.47	-0.55	0.58		-17.61	10.71	-1.972	0.05	.
	A×G	-41.93	28.22	-1.48	0.15		-2.57	21.30	-0.12	0.90	
	A×E	4.15	26.72	0.15	0.87		23.00	21.43	1.07	0.28	
	G×E	**-42.96**	**27.12**	**-1.58**	**0.01**	**	0.55	21.43	0.02	0.97	
	A×G×E	12.62	55.24	0.22	0.82		27.56	42.88	0.64	0.52	
V + 3											
	Attr.	5.02	13.40	0.37	0.71		-8.46	11.97	-0.70	0.48	
	Gram.	-0.89	13.18	-0.06	0.94		8.67	11.94	-0.72	0.47	
	Ell.	7.52	13.20	0.57	0.57		-1.63	8.37	-0.19	0.84	
	A×G	**-60.53**	**26.60**	**-2.27**	**< 0.05**	*	-39.62	23.84	-1.66	0.10	
	A×E	-38.17	26.24	-1.45	0.16		-3.10	16.74	-0.18	0.85	
	G×E	-19.90	26.41	-0.75	0.45		4.47	16.75	0.26	0.79	
	A×G×E	-15.73	52.86	-0.29	0.76		43.46	33.54	1.29	0.20	

Table 11: Means for Experiment 2 by region, subset by Head Type (Derived/Simple).

			DERIVED				SIMPLE			
ELLIPSIS	GRAM.	ATTR.	V	V+1	V+2	V+3	V	V+1	V+2	V+3
NE	G	SG	328	293	298	287	335	304	342	310
NE	G	PL	330	283	302	344	359	343	319	327
NE	UG	SG	380	382	361	318	342	349	348	332
NE	UG	PL	350	324	332	324	310	333	309	308
E	G	SG	344	324	337	341	333	296	305	304
E	G	PL	347	325	338	346	326	308	302	306
E	UG	SG	373	366	329	347	333	345	317	331
E	UG	PL	310	325	276	289	329	327	304	313

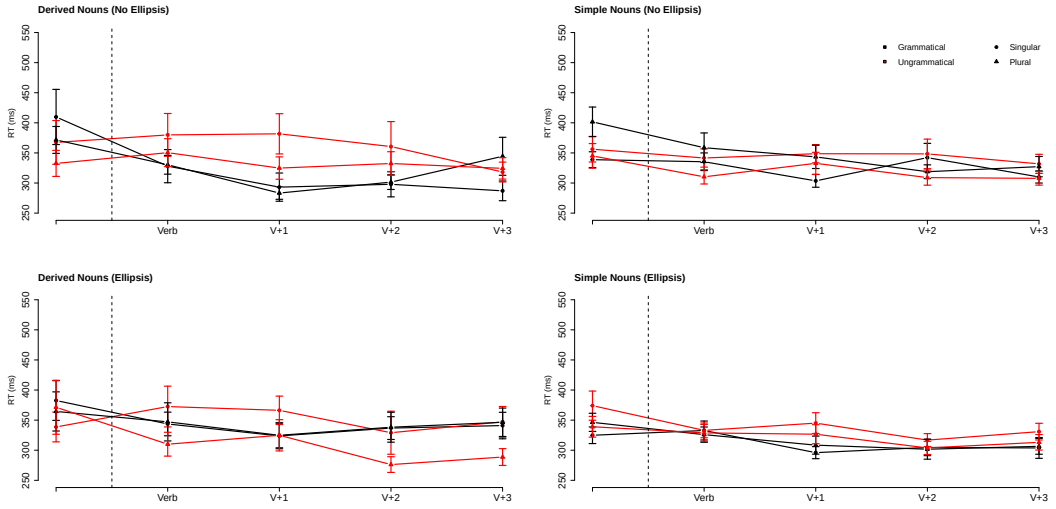


Figure 4: Self-paced reading results of Experiment 2, NO ELLIPSIS (Top) & ELLIPSIS (Bottom), subset by Head Type: Derived (Left), Simple (Right). Region by region means by ATTRACTOR and GRAMMATICALITY. Error bars indicate standard error of the mean.
Sample: . . . *was/were*$_{Verb}$ *at*$_{V+1}$ *the*$_{V+2}$ *office*$_{V+3}$

3.2.5 Discussion

The data from Experiment 2 patterned like that in Experiment 1; there were main effects of ATTRACTOR and GRAMMATICALITY as well as the crucial interaction between the two. In looking at the data as a whole, the agreement attraction effect emerged as significant. The ungrammatical conditions were read more slowly and the singular attractor conditions were read more slowly. The grammaticality effect is expected, and as per the results from Experiment 1, the speed up for the plural attractors indicates

the possibility for attraction.

Due to the nature of the design, the attraction effect should only emerge in the Ellipsis condition, and not the No Ellipsis condition. There were no significant or approaching interactions with ELLIPSIS, which could suggest that the attraction was found in both conditions.

Ellipsis vs. No Ellipsis

Since an interaction with ELLIPSIS was expected, the data were split and re-analyzed by this factor. Interestingly, the attraction effects were present within the No Ellipsis condition, but not the Ellipsis condition, *contra* expectation. The Ellipsis data only exhibits a sensitivity to GRAMMATICALITY. There were no effects of ATTRACTOR, either the crucial interaction, or the speed-up for plurals that is suggestive of attraction.

In the No Ellipsis data, there were significant effects for ATTRACTOR, which interacted with GRAMMATICALITY, generating an attraction effect. The speed-up for plurals that emerged in Experiment 1 is seen at V+2, but only approached significance. At V+3, the attraction effect re-emerged as significant. In looking at the whole analysis and the split analysis, the pattern within the data as a whole emerges from the No Ellipsis condition, and not the Ellipsis condition.

The possibility of attraction in the No Ellipsis condition is surprising. Since the possessor, which licenses ellipsis, is not present within the No Ellipsis condition, nothing should be reactivated. A possible explanation here is that agreement attraction can occur at a distance. The materials for Experiment 2 had two clauses; the first providing the antecedent for the second. In the No Ellipsis condition, there is no plural that could trigger attraction within the local clause, however, the plural from the antecedent clause may still be accessible and cause attraction. Thus, these data suggest that long-distance (cross-clausal) agreement attraction is possible. This 'long-distance' attraction has not been previously observed. See the general discussion in §4 for further explanation regarding how non-local attraction may occur in this bi-clausal configuration.

In the Ellipsis data, there was only a main effect of GRAMMATICALITY; ungrammat-

ical conditions were read more slowly. This indicates that there is at least sensitivity to the mismatch in features between the head noun and the ungrammatical, agreeing verb, though no attraction.

Derived Nouns vs. Simple Nouns

The derived nouns, again, drive the effects rather than the simple nouns. The pattern of where the attraction occurs (V+1 and V+3) is found within the derived nouns, not the simple nouns. The ATTRACTOR and GRAMMATICALITY interaction only approaches significance, but the pattern is indicative of agreement attraction. Further, the speed up for plural attractor conditions also approaches significance. Together, these patterns suggest attraction, though it does not emerge as significant. Interestingly, at V+2, the grammatical conditions in the Ellipsis condition were read more slowly for the derived nominals, whereas in the No Ellipsis condition, the ungrammatical conditions were read more slowly. The pattern in the No Ellipsis data looks like a simple grammaticality effect, however, in the Ellipsis data, it is unclear why all ungrammatical conditions would be read more quickly. While reading the ungrammatical, plural attractor condition more quickly would be indicative of attraction, its puzzling why the fully ungrammatical condition with a singular attractor and ungrammatical verb would also be read more quickly. This could potentially be indicative of agreement attraction, but the issue with the baseline condition weakens this claim. The final region of analysis illustrated a similar pattern, where the ATTRACTOR with GRAMMATICALITY interaction emerges as significant; in the No Ellipsis data, there seems to be a penalty when attraction does *not* occur, and then in the Ellipsis data, the attraction condition is read the fastest. If, for some reason, there is a penalty for failing to attract, then perhaps there is some suggestion of attraction in the Ellipsis data. However, even if there is a penalty for failing to attract and complete ungrammaticality, the fully grammatical baseline singular attractor, grammatical verb condition patterns with these, again weakening this claim.

In the case of the simple nouns, several effects emerge at the verb, but there seems

to only be a robust effect of GRAMMATICALITY in subsequent regions. The effects here were due in part to the increase in reading time for the plural attractor, grammatical verb condition; there is no agreement attraction. The simple nouns generate strong GRAMMATICALITY effects. The main effect of ATTRACTOR also approached significance and followed the same plural speed up pattern, though, the attraction effect did not emerge as significant. The pattern downs't suggest attraction. A point of interest: attraction does, impressionistically, seem to occur in the V+3 region for the simple nouns, though non-significantly. In the derived noun data, this interaction was significant, but was not the characteristic agreement attraction pattern. Here, the characteristic pattern *does* emerge. However, recall that long distance agreement attraction was possible. Even though this effect is found only within the Ellipsis data, there is no real way to tease apart if its derived from the reactivation of the attraction-triggering nominal or if attraction has occurred at a distance or potentially that it is some combination of the two.

Experiment 2 reveals something novel about attraction: it is possible across clauses. Why might attraction be able to occur at such a long distance? This experiment used causal and contrastive connectives to join the clauses. Potentially, the discourse relations instantiated by these connectives allows for this possibility. In cause-effect relations, the clauses are dependent on each other, or are more closely related. Rather than each claus describing an event, these connectives implicate that both clauses together provide a description of some event. The antecedent clause, though non-local, could still be very available given this discourse relation. Further, such a relation could favor greater parallelism between the two clauses. This may cause a prediction that ellipsis is expected in the second clause, given that the first contains a configuration that makes ellipsis possible (Lau et al., 2006). The plural attractor could be more available if the materials was predicted to be used again, or, if when ellipsis is predicted, that constituent is re-accessed, deriving the long-distance effects. Thus, there are two explanations for long-distance attraction: its due to the discourse relations or due to a predic-

tive parse. To address long-distance attraction, and to try and observe the amount of structure reactivated without this confound, Experiment 3 uses temporal connectives rather than causal/contrastive subordinators. These should instantiate less parallelism by changing the discourse relation and ideally, should remove the possibility for long-distance attraction.

3.3 Experiment 3

Experiment 3, like Experiment 2, examines attraction-triggering nominals under ellipsis. Again, the same complex nominals from Experiment 1, that do generate agreement attraction, were used as antecedents for NPE. Experiment 3 addresses the issue of parallelism introduced in Experiment 2 by using temporal connectives as opposed to causal/contrastive connectives.

3.3.1 Participants

Participants were 64 individuals recruited on MechanicalTurk; they were compensated $8.50/h.

3.3.2 Materials

The materials for Experiment 3 mirrored those of Experiment 2. The experiment employed a 2x2x2 design crossing the factors of the number of the ATTRACTOR (Singular (SG)/Plural (PL)), the GRAMMATICALITY of the agreeing verb (Grammatical (G)/Ungrammatical (UG), and ELLIPSIS (No Ellipsis/Ellipsis). 32 sets were constructed and items were distributed via a Latin Square over 32 lists. Each list was combined with 64 fillers for a total of 96 items per participant. An example set is given in Table 12. Full materials are given in Appendix C. Items were again bi-clausal, the first clause providing the antecedent and the second, the potential site for ellipsis. The clauses followed the same templates as in Experiment 2, first clause *Name's–noun–preposition–determiner–noun–verb–verb*, second clause, *Name–Adverb–be–predicate*. Ellipsis was licensed by the presence of the possessor following the name in the second clause. The agreeing verb showed no difference in form between the singular and plural form, an adverb preceded the agreeing verb in the second clause allowing for time for reactivation, and locative or temporal prepositional phrases followed the agreeing verb of the second clause to provide a spill-over region.

Table 12: Example item set for Experiment 3.

No Ellipsis	GRAM.	ATTR.	
	G	SG	Harold's key to the room$_{SG}$ got replaced even after Steven surprisingly was$_{G}$ able to be tracked down.
	G	PL	Harold's key to the rooms$_{PL}$ got replaced even after Steven surprisingly was$_{G}$ able to be tracked down.
	UG	SG	Harold's key to the room$_{SG}$ got replaced even after Steven surprisingly were$_{UG}$ able to be tracked down.
	UG	PL	Harold's key to the rooms$_{PL}$ got replaced even after Steven surprisingly were$_{UG}$ able to be tracked down.
Ellipsis	GRAM.	ATTR.	
	G	SG	Harold's key to the room$_{SG}$ got replaced even after Steven's surprisingly was$_{G}$ able to be tracked down.
	G	PL	Harold's key to the rooms$_{PL}$ got replaced even after Steven's surprisingly was$_{G}$ able to be tracked down.
	UG	SG	Harold's key to the room$_{SG}$ got replaced even after Steven's surprisingly were$_{UG}$ able to be tracked down.
	UG	PL	Harold's key to the rooms$_{PL}$ got replaced even after Steven's surprisingly were$_{UG}$ able to be tracked down.

The difference between Experiment 2 and Experiment 3 was the type of connective used. Here, temporal subordinators (e.g., *before, after*) were used.

This experiment employs an additional counterbalance. Potentially, no attraction effects emerged in Experiment 2 as subordinated clauses may not be attended to as carefully as main clauses. Since the ellipsis site always occurred in a subordinated position, perhaps this caused the lack of effects. In order to assess this claim, the location of the clause headed by the temporal subordinator is manipulated. This counterbalance will be called the Ellipsis Site Location. The ellipsis site occurs either within a Subordinate or a Non-Subordinate clause. Exmaples are given below.

(31) Harold's key to the room got replaced
after Steven surprisingly was able to be tracked down.

(32) After Harold's key to the room got replaced,
Steven surprisingly was able to be tracked down.

In (30), the ellipsis site occurs with the Subordinate Clause. In (31), the ellipsis site occurs within the main clause.

3.3.3 Procedure & Analysis

The same self-paced reading procedure was used as in Experiment 2. The analysis conducted was the same; mixed-effects linear models were fit to the data. Further analysis split the data by the factor of ELLIPSIS, as well as by both counterbalances, Head Noun (Simple/Derived) and Ellipsis Site Location (Subordinate/Non-Subordinate).

3.3.4 Results

The reading time results from Experiment 3 are presented in Figures 5–7 and in Tables 13–19. The regions for analysis included the verb and the three following regions, i.e., words, (V+1, V+2, and V+3).

At the verb, there were no significant effects. At V+1, there was a significant effect of GRAMMATICALITY; ungrammatical conditions were read more slowly. The main effect of ATTRACTOR approached significance; singular attractor conditions were read more quickly than plural attractor conditions. This effect persisted into the V+2 region. In the V+3 region, the interaction of ATTRACTOR with ELLIPSIS approached significance; the plural attractor conditions were read more quickly within the Ellipsis data.

As in Experiment 2, the data were split on the ELLIPSIS factor. As the same design was employed, interactions with ELLIPSIS were predicted.

Ellipsis

At V+1, the main effect of GRAMMATICALITY approached significance; ungrammatical conditions were read more slowly.

No Ellipsis

At the verb, the main effect of ATTRACTOR approached significance; conditions with plural attractors were read more slowly. At V+1, this effect emerged as significant, with the same pattern. The main effect of GRAMMATICALITY approached significance; ungrammatical conditions were read more slowly overall.

Table 13: Mixed-effect model coefficient table for Experiment 3.
Bold values indicate statistical significance

		β	SE	t	p	
Verb						
	Attractor	12.52	10.7	1.17	0.24	
	Grammaticality	13.96	11.55	1.21	0.22	
	Ellipsis	10.39	10.64	0.97	0.32	
	Attractor × Grammaticality	29.25	30.91	0.94	0.35	
	Attractor × Ellipsis	-31.41	21.31	-1.47	0.14	
	Grammaticality × Ellipsis	19.63	21.26	0.92	0.35	
	Attractor × Gramm. × Ellipsis	-25.09	42.51	-0.59	0.55	
V + 1						
	Attractor	25.21	14.11	1.78	0.07	.
	Grammaticality	**38.18**	**13.76**	**2.77**	**0.006**	**
	Ellipsis	-8.34	11.78	-0.71	0.47	
	Attractor × Grammaticality	11.52	32.86	0.35	0.72	
	Attractor × Ellipsis	-32.47	23.61	-1.37	0.16	
	Grammaticality × Ellipsis	-9.67	23.55	-0.41	0.68	
	Attractor × Gramm. × Ellipsis	26.36	47.04	0.56	0.57	
V + 2						
	Attractor	20.641	11.481	1.798	0.079	.
	Grammaticality	8.563	14.013	0.611	0.544	
	Ellipsis	-9.221	6.648	-1.387	0.166	
	Attractor × Grammaticality	-5.297	26.776	-0.198	0.844	
	Attractor × Ellipsis	-12.28	13.3	-0.923	0.356	
	Grammaticality × Ellipsis	-19.899	13.28	-1.498	0.134	
	Attractor × Gramm. × Ellipsis	15.289	26.547	0.576	0.565	
V + 3						
	Attractor	3.11	9.67	0.32	0.74	
	Grammaticality	4.18	9.31	0.44	0.65	
	Ellipsis	-7.88	9.06	-0.86	0.38	
	Attractor × Grammaticality	27.25	22.48	1.21	0.23	
	Attractor × Ellipsis	-35.16	18.14	-1.93	0.05	.
	Grammaticality × Ellipsis	-16.56	18.08	-0.91	0.36	
	Attractor × Gramm. × Ellipsis	-14.06	36.17	-0.38	0.69	

Table 14: Means for Experiment 3 by region.

Ellip.	Attr.	Gramm.	V	V+1	V+2	V+3
NE	G	SG	336	322	312	317
NE	G	PL	350	356	331	308
NE	UG	SG	326	366	328	302
NE	UG	PL	362	391	346	335
E	G	SG	338	334	313	317
E	G	PL	343	328	302	286
E	UG	SG	362	348	302	302
E	UG	PL	363	370	324	295

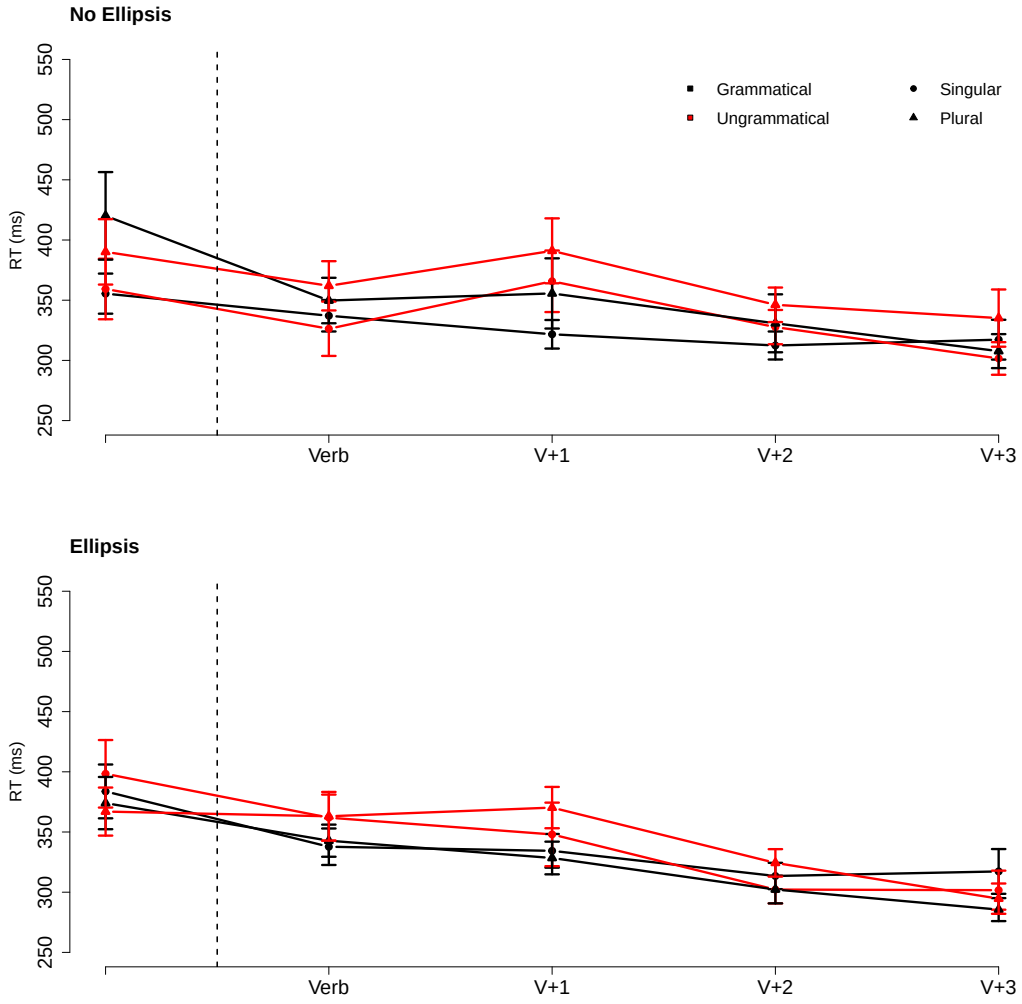


Figure 5: Self-paced reading results of Experiment 3, NO ELLIPSIS (Top) & ELLIPSIS (Bottom). Region by region means by ATTRACTOR and GRAMMATICALITY. Error bars indicate standard error of the mean.
Sample: . . . *was/were*$_{Verb}$ *at*$_{V+1}$ *the*$_{V+2}$ *office*$_{V+3}$

Table 15: Mixed-effect model coefficient table for Experiment 3, split by ELLIPSIS factor. Bold values indicate statistical significance.

		ELLIPSIS					NO ELLIPSIS				
		β	SE	t	p		β	SE	t	p	
Verb											
	Attr.	1.86	14.33	0.12	0.89		**29.87**	**15.38**	**1.94**	**0.05**	·
	Gram.	23.53	14.55	1.62	0.10		-1.99	15.65	-0.12	0.89	
	A×G	4.26	29.06	0.14	0.88		21.64	31.48	0.68	0.49	
V+1											
	Attr.	1.68	14.86	0.11	0.90		**39.72**	**18.78**	**2.11**	**< 0.05**	*
	Gram.	**28.24**	**14.99**	**1.88**	**0.06**	·	**37.01**	**19.12**	**1.93**	**0.05**	·
	A×G	24.15	30.12	0.80	0.42		-4.06	38.45	-0.10	0.91	
V+2											
	Attr.	2.71	8.65	0.31	0.75		19.71	12.05	1.63	0.10	
	Gram.	8.45	8.74	0.96	0.33		21.56	12.29	1.75	0.08	
	A×G	24.13	17.58	1.37	0.17		-7.99	24.73	-0.32	0.74	

The data reported below are based on models constructed based on the data after it was subset into two data sets by the Head Noun Type counterbalance.

Derived Nouns

At the verb, the main effect of ELLIPSIS was significant; the Ellipsis condition was read more slowly than the No Ellipsis condition. The interaction of GRAMMATICALITY with ELLIPSIS was also significant; ungrammatical conditions were read more slowly in the No Ellipsis condition. At V+1, the main effect of GRAMMATICALITY approached significance. The ungrammatical conditions were read more slowly. At V+3, the main effect of ATTRACTOR was significant; plural attractor conditions were read more quickly.

Table 16: Mixed-effect model coefficient table for Experiment 3, subset by Head Type (Derived/Simple). Bold values indicate statistical significance

		Derived					Simple				
		β	SE	t	p		β	SE	t	p	
Verb											
	Attr.	14.65	17.65	0.83	0.40		8.37	4.04	2.07	0.03	*
	Gram.	15.09	17.59	0.85	0.39		-13.11	4.16	-3.14	0.001	**
	Ell.	41.05	17.48	2.34	0.01	*	-1.39	4.11	-0.33	0.73	
	A×G	22.01	35.33	0.62	0.53		-3.68	8.38	-0.43	0.66	
	A×E	-40.86	34.71	-1.17	0.23		-16.69	8.11	-2.05	0.03	*
	G×E	89.11	34.88	2.54	0.01	*	-17.76	8.19	-2.16	0.03	*
	A×G×E	-2.51	69.13	-0.03	0.97		23.65	16.41	1.44	0.14	
V+1											
	Attr.	24.16	18.86	1.28	0.20		13.23	16.48	0.80	0.42	
	Gram.	33.79	19.33	1.74	0.08	.	31.28	17.08	1.83	0.06	.
	Ell.	-16.59	18.81	-0.88	0.37		2.43	16.44	0.14	0.88	
	A×G	25.87	38.61	0.67	0.50		-6.55	33.97	-0.19	0.84	
	A×E	-41.43	37.07	-1.11	0.26		-23.38	32.75	-0.71	0.47	
	G×E	24.13	37.6	0.64	0.52		-39.12	32.67	-1.19	0.23	
	A×G×E	79.42	74.12	1.07	0.28		-0.71	65.28	-0.01	0.99	
V+2											
	Attr.	-3.00	13.32	-0.22	0.82		16.42	9.38	1.75	0.08	.
	Gram.	17.49	13.89	1.26	0.20		1.64	10.10	0.16	0.87	
	Ell.	-9.05	13.31	-0.68	0.49		-11.38	9.38	-1.21	0.22	
	A×G	4.15	27.72	0.15	0.88		14.41	19.81	0.72	0.46	
	A×E	-30.66	26.13	-1.17	0.24		-7.48	18.63	-0.40	0.68	
	G×E	-13.32	26.74	-0.49	0.61		-19.61	18.68	-1.04	0.29	
	A×G×E	86.76	52.38	1.65	0.09	.	2.97	37.00	0.08	0.93	
V+3											
	Attr.	-37.22	14.68	-2.53	0.01	*	37.46	15.89	1.42	0.15	
	Gram.	6.36	14.51	0.43	0.66		14.28	16.35	0.87	0.38	
	Ell.	2.52	14.54	0.17	0.86		-12.72	11.07	-1.14	0.25	
	A×G	26.17	29.31	0.89	0.37		25.96	32.19	0.80	0.42	
	A×E	-16.46	28.77	-0.57	0.56		-38.40	22.06	-1.74	0.08	.
	G×E	-12.97	28.91	-0.45	0.65		-23.99	22.07	-1.08	0.22	
	A×G×E	19.41	57.24	0.33	0.73		-35.86	43.86	-0.81	0.41	

Table 17: Means for Experiment 3 by region, subset by Head Type (Derived/Simple).

			Derived				Simple			
Ellip.	Attr.	Gramm.	V	V+1	V+2	V+3	V	V+1	V+2	V+3
NE	G	SG	329	312	300	334	343	329	321	305
NE	G	PL	336	362	329	298	363	350	332	317
NE	UG	SG	339	362	336	307	314	370	320	297
NE	UG	PL	318	373	341	316	402	408	351	353
E	G	SG	326	325	314	333	350	344	313	301
E	G	PL	337	318	295	284	350	341	311	288
E	UG	SG	358	314	302	301	365	376	303	302
E	UG	PL	377	367	321	288	353	373	327	300

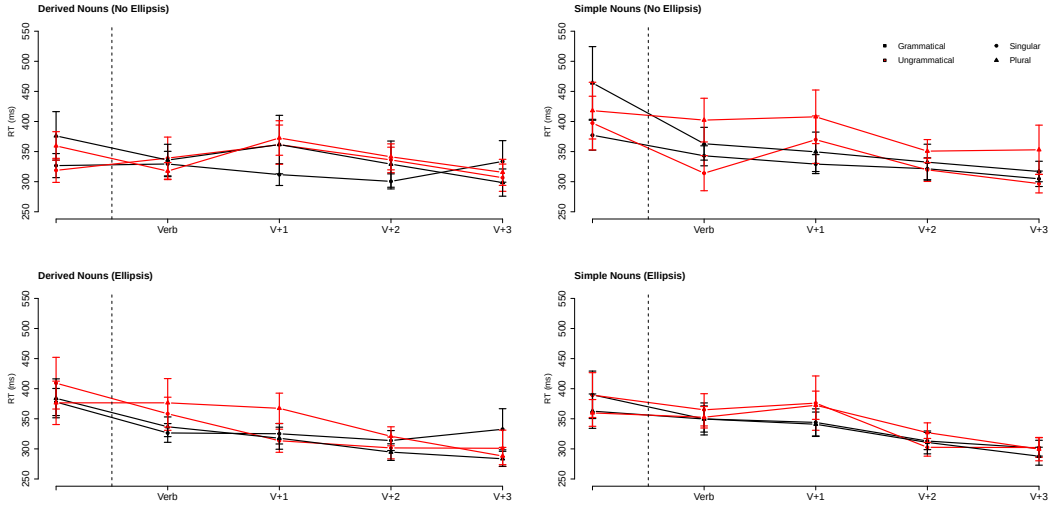


Figure 6: Self-paced reading results of Experiment 3, NO ELLIPSIS (Top) & ELLIPSIS (Bottom), subset by Head Type: Derived (Left), Simple (Right). Region by region means by ATTRACTOR and GRAMMATICALITY. Error bars indicate standard error of the mean.
Sample: . . . *was/were*$_{Verb}$ *at*$_{V+1}$ *the*$_{V+2}$ *office*$_{V+3}$

Simple Nouns

At the verb, there were main effects for ATTRACTOR and GRAMMATICALITY. Plural attractor conditions and ungrammatical conditions were read more slowly. These main effects also both interacted with ELLIPSIS. Plural attractors were read more slowly in the ELLIPSIS condition and ungrammatical conditions were read more slowly in the NO ELLIPSIS condition. At V+1, the main effect of GRAMMATICALITY approached significance; plural attractor conditions were read more slowly. At V+2, the main effect of ATTRACTOR approaches significance; plural attractors were read more slowly. At V+3, the interaction of ATTRACTOR with ELLIPSIS approached significance; plural attractors were read more slowly in the ELLIPSIS condition.

Table 18: Mixed-effect model coefficient table for Experiment 3, subset by Ellipsis Site Location (Non-Subordinate/Subordinate).
Bold values indicate statistical significance.

		Non-Subordinate					Subordinate				
		β	SE	t	p		β	SE	t	p	
Verb											
	Attr.	**27.03**	**13.22**	**2.04**	**< 0.05**	*	-3.93	16.76	-0.23	0.81	
	Gram.	-5.76	13.28	-0.43	0.66		**37.35**	**17.42**	**2.14**	**< 0.05**	*
	Ell.	**27.68**	**13.26**	**2.08**	**< 0.05**	*	-7.80	16.74	-0.46	0.64	
	A×G	8.73	27.10	0.32	0.74		6.00	34.54	0.17	0.86	
	A×E	-21.42	26.35	-0.81	0.41		-44.96	33.93	-1.32	0.18	
	G×E	-6.15	26.30	-0.23	0.81		29.24	33.67	0.86	0.38	
	A×G×E	-46.54	52.78	-0.88	0.37		-9.13	66.89	-0.13	0.89	
V+1											
	Attr.	7.66	18.40	0.41	0.67		20.09	15.15	1.32	0.18	
	Gram.	**40.40**	**18.48**	**2.18**	**< 0.05**	*	**31.80**	**15.80**	**2.01**	**0.04**	*
	Ell.	-16.28	18.46	-0.88	0.37		-3.08	15.11	-0.20	0.83	
	A×G	45.16	37.79	1.19	0.23		-20.75	31.18	-0.66	0.50	
	A×E	**-67.08**	**36.67**	**-1.82**	**0.06**	·	-11.10	30.40	-0.32	0.74	
	G×E	-20.96	36.61	-0.57	0.56		-9.74	30.40	-0.32	0.74	
	A×G×E	14.43	73.42	0.19	0.84		53.12	60.37	0.87	0.37	
V+2											
	Attr.	7.73	10.19	0.75	0.44		6.79	10.59	0.64	0.52	
	Gram.	**23.40**	**10.23**	**2.09**	**0.03**	*	9.70	11.08	0.87	0.38	
	Ell.	-14.57	10.22	-1.42	0.15		-1.88	10.58	-0.17	0.85	
	A×G	26.93	20.91	1.28	0.19		-11.4-	21.93	-0.52	0.60	
	A×E	-7.93	20.31	-0.39	0.69		-23.43	21.48	-1.09	0.27	
	G×E	-19.73	20.27	-0.97	0.33		-20.36	21.31	-0.95	0.33	
	A×G×E	18.22	40.66	0.44	0.65		7.98	42.26	0.18	0.85	
V+3											
	Attr.	-0.70	8.54	-0.08	0.93		0.88	14.91	0.05	0.95	
	Gram.	2.32	8.57	0.27	0.78		15.26	15.61	0.97	0.32	
	Ell.	-9.42	8.56	-1.10	0.27		-3.12	14.86	-0.21	0.83	
	A×G	7.03	17.57	0.40	0.68		25.13	30.76	0.81	0.41	
	A×E	**-57.24**	**17.02**	**-3.29**	**< 0.00**	**	-21.57	30.18	-0.71	0.47	
	G×E	-16.80	16.97	-0.98	0.32		-22.25	29.92	-0.74	0.45	
	A×G×E	-21.77	34.05	-0.63	0.52		-17.36	59.39	-0.29	0.77	

Table 19: Means for Experiment 3 by region, subset by Ellipsis Site Location (Non-Subordinate/Subordinate).

			NON-SUBORDINATE				SUBORDINATE			
Ellip.	Attr.	Gramm.	V	V+1	V+2	V+3	V	V+1	V+2	V+3
NE	G	SG	319	324	310	300	349	320	314	328
NE	G	PL	344	351	321	305	355	360	339	310
NE	UG	SG	298	363	334	294	365	370	318	312
NE	UG	PL	343	407	354	330	386	371	336	341
E	G	SG	344	345	315	310	333	371	336	341
E	G	PL	371	313	286	277	321	340	315	292
E	UG	SG	345	357	302	306	386	335	302	295
E	UG	PL	365	373	340	283	362	367	306	309

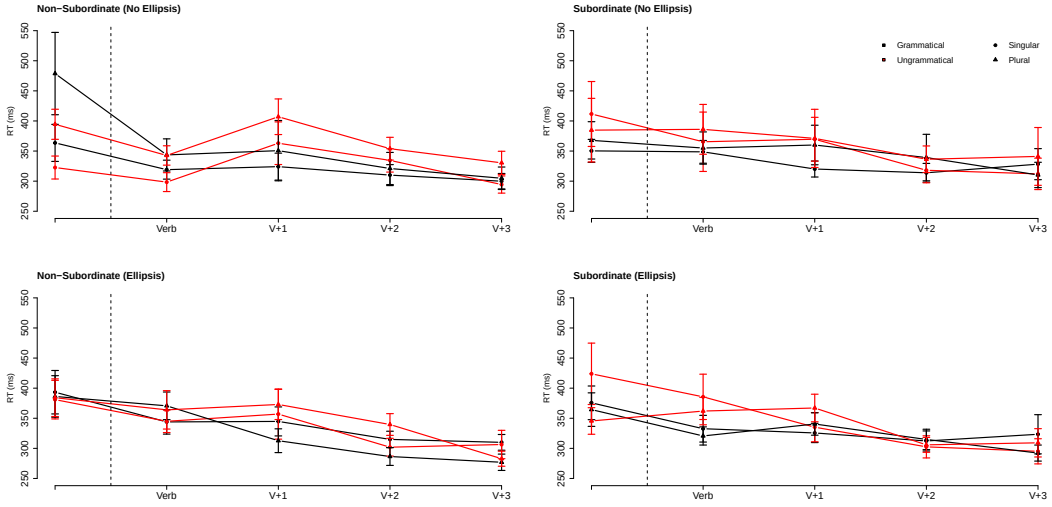


Figure 7: Self-paced reading results of Experiment 3, NO ELLIPSIS (Top) & ELLIPSIS (Bottom), subset by Ellipsis Site Location: Non-Subordinate (Left), Subordinate (Right). Region by region means by ATTRACTOR and GRAMMATICALITY. Error bars indicate standard error of the mean. Sample: . . . *was/were*$_{Verb}$ *at*$_{V+1}$ *the*$_{V+2}$ *office*$_{V+3}$

The data reported below are based on models constructed based on the data after it was subset into two data sets by the Ellipsis Site Location counterbalance.

Non-Subordinate

At the verb, there were significant main effects for both ATTRACTOR and ELLIPSIS. Conditions with plural attractors were read more slowly. The ELLIPSIS condition was read more slowly overall than NO ELLIPSIS. At V+1, there was a significant main effect of GRAMMATICALITY. Ungrammatical conditions were read more slowly. There

was an interaction of ATTRACTOR with ELLIPSIS which approached significance; conditions with plural attractors were read more slowly in the NO ELLIPSIS condition. At V+2, the main effect of GRAMMATICALITY persisted significantly, following the same trend. At V+3, there was again an interaction of ATTRACTOR and ELLIPSIS; singular attractors were read more slowly in the ellipsis condition.

Subordinate

At the verb, there was a significant main effect of GRAMMATICALITY; ungrammatical conditions were read more slowly. This effect persisted with the same pattern at V+1.

3.3.5 Discussion

In Experiment 3, the only effect that reached significance was GRAMMATICALITY. There was only sensitivity to the mismatch in features of the head noun and the agreeing verb, and no attraction. In some regions, the main effect of ATTRACTOR approached significance, but this effect was that plural attractors were read slower, not faster, than the singular attractors. If attraction were possible, there would be an expected speed up for the plural condition, which is not reflected in this data. At the V+3 region, ATTRACTOR interacted with ELLIPSIS. Here, the plural attractor conditions were read more quickly in the Ellipsis condition. This *is* suggestive of attraction (since there is a speed up for plurals), but this did not emerge as significant, nor did the crucial interaction.

These data are compatible with an explanation that appeals to the size of the reactivated constituent. It was hypothesized that the constituent in its entirety would be reactivated, i.e., both the head noun and the attractor. However, it is possible that under ellipsis, only a portion of this structure is reactivated. If only the head noun were reactivated, the only effect that would be predicted is GRAMMATICALITY—exactly the present pattern. This is because the head noun is always singular which mismatches with the plural features on the ungrammatical verb. Attraction is not predicted to occur

as the plural number features of the attractor were simply never reactivated. However, if these features are never reactivated, the speed up for the plural attractor conditions in the V+3 region is left unexplained. Potentially, there is full reactivation, but due to various factors, perhaps the strength of the attraction effect is damped. See the General Discussion in §4 for further discussion regarding the factors that may inhibit attraction.

Ellipsis vs. No Ellipsis

The data were split by the ELLIPSIS factor in order to analyze the Ellipsis condition separately from the No Ellipsis condition. Again, this design should only allow for attraction in the Ellipsis condition, and not the No Ellipsis condition, unless there is the possibility for long distance attraction. If so, these effects would emerge in the split analysis, where it becomes clear which condition is deriving the effects. Recall that in Experiment 2, at V+3 there was a potential effect of attraction within the Ellipsis data. However, in Experiment 2, these effects could be the result of long distance attraction. Here, there does not seem to be the same possibility, as no effects of attraction are seen in the regions where long distance attraction effects arose in the previous experiment.

In the Ellipsis condition, ungrammatical conditions were read more slowly, as is expected. Similarly in the No Ellipsis condition, there was only sensitivity to GRAMMATICALITY. Further, while there are significant and approaching effects of ATTRACTOR, they are not in the direction that would be indicative of attraction; plurals are read slower, not faster.

In this experiment, there are no effects that suggest long distance attraction. Why long distance attraction was possible in previous experiment, but not within this experiment, is discussed in the General Discussion in §4. Further, the sensitivity to only GRAMMATICALITY can be explained by appealing to partial reactivation, as previously discussed.

Considering that there is no evidence for long distance attraction in this experiment, the speed up for the plurals that emerged across the entire data could potentially be a late effect suggestive of attraction; here, this is not weakened by the possibility of

long distance attraction. However, since this effect does not emerge in the split analysis, it is not clear if it is occurring in the Ellipsis or No Ellipsis data. It would not be surprising if effects from a reactivated constituent occurred later, as the processing of reactivated structure plausibly takes longer than the processing of overt structure. However, the speed-up for plurals is only suggestive attraction, and perhaps shouldn't be taken too strongly as evidence for full reactivation.

Derived Nouns vs. Simple Nouns

The data were subset by the Head Type counterbalance. For the derived nouns, there was only an effect of GRAMMATICALITY. As is expected, ungrammatical conditions were read more slowly than grammatical conditions. When the ATTRACTOR effect does arise, it is in the wrong direction; plural conditions are read more slowly.

For simple nouns, at the verb, there are multiple significant effects. The ATTRACTOR effect follows the same pattern as in the derived nouns—plural attractor conditions are read more slowly. The GRAMMATICALITY effect was also expected. Of interest are the two interactions of these main effects with ELLIPSIS. Again, the ATTRACTOR condition patterns as if there is no potential for attraction; plural attractor conditions are read more slowly in Ellipsis. Ungrammatical conditions were also read more slowly in Ellipsis. The fact that these interactions with Ellipsis occur strongly suggests that there is no possibility of full reactivation.

Neither the derived nouns or simple nouns derive stronger attraction effects. There are only effects of partial reactivation as evidenced by the effects of GRAMMATICALITY.

Non-Subordinated vs. Subordinated

The data were subset by the Ellipsis Site Location counterbalance. For the Subordinated data, there were only effects of GRAMMATICALITY. These same effects arose in the Non-Subordinated data, as did some effects of ATTRACTOR. At the verb, plural attractor conditions are read more slowly. This effect reverses at the V+3 region. As previously discussed, this speed up for the plurals, which is found *only* in the Ellipsis data (and further, when long distance attraction does not seem possible), perhaps sug-

gests that attraction is possible. This effect arises only in the Non-Subordinated data, and not within the Subordinated data.

Experiment 3 illustrates that there is only sensitivity to GRAMMATICALITY, which is compatible with partial reactivation. There was no evidence for long distance attraction within this experiment. In the final region of analysis, there was a speed up for the plural attractor condition, which could be indicative of attraction. This only emerges as significant within the fronted data and derived nominal data. This one suggestive fact aside, the data, overall, are compatible with a theory of partial reactivation.

3.4 Experiment 4

Experiment 4 tests the claim put forth given the data from Experiments 2-3: that reactivation is partial—only the head is reactivated. Rather than eliding the entire attraction-triggering nominal, only the attractor is elided, which is a head.

3.4.1 Participants

Participants were 64 individuals recruited on MechanicalTurk; they were compensated \$8.50/h.

3.4.2 Materials

The materials for Experiment 4 were adapted from the materials for Experiments 2 & 3. The experiment employed a 2x2x2 design crossing the factors of the number of the ATTRACTOR (Singular (SG)/Plural (PL)), the GRAMMATICALITY of the agreeing verb (Grammatical (G)/Ungrammatical (UG), and ELLIPSIS (No Ellipsis/Ellipsis). 32 sets were constructed and items were distributed via a Latin Square over 32 lists. Each list was combined with 64 fillers for a total of 96 items per participant. Only the location of the licensor of ellipsis changes. Rather than eliding the entire attraction-triggering nominal (i.e., John's <key to the cabinets>), only the attractor is elided (i.e., the key to John's <cabinets>). Ellipsis was licensed by the presence of the possessor following the name in the second clause. The verb showed no difference in form between the singular and plural form, an adverb preceded the agreeing verb in the second clause allowing for time for reactivation, and locative or temporal prepositional phrases followed the agreeing verb of the second clause to provide a spill-over region. An example set is given in Table 20. Full materials are given in Appendix D.

Table 20: Sample set of experimental items for Experiment 4.

No Ellipsis	GRAM.	ATTR.	
	G	SG	Before the memo from Harvey's architect$_{SG}$ could be found, the report from Frank accidentally was$_{G}$ sent to the boss.
	G	PL	Before the memo from Harvey's architects$_{PL}$ could be found, the report from Frank accidentally was$_{G}$ sent to the boss.
	UG	SG	Before the memo from Harvey's architect$_{SG}$ could be found, the report from Frank accidentally were$_{UG}$ sent to the boss.
	UG	PL	Before the memo from Harvey's architects$_{PL}$ could be found, the report from Frank accidentally were$_{UG}$ sent to the boss.
Ellipsis			
	G	SG	Before the memo from Harvey's architect$_{SG}$ could be found, the report from Frank's accidentally was$_{G}$ sent to the boss.
	G	PL	Before the memo from Harvey's architects$_{PL}$ could be found, the report from Frank's accidentally was$_{G}$ sent to the boss.
	UG	SG	Before the memo from Harvey's architect$_{SG}$ could be found, the report from Frank's accidentally were$_{UG}$ sent to the boss.
	UG	PL	Before the memo from Harvey's architects$_{PL}$ could be found, the report from Frank's accidentally were$_{UG}$ sent to the boss.

3.4.3 Procedure & Analysis

The same self-paced reading procedure was used. The analysis conducted was the same; mixed-effects linear models were fit to the data. Additional analysis subset the data on the factor of ELLIPSIS, as well as by the Ellipsis Site Location counterbalance. In this experiment, the data were not subset by Head Noun Type as the head noun of the attraction triggering nominal is never elided.

3.4.4 Results

The reading time results from Experiment 4 are presented in Figures 8–9 and in Tables 21–25. The regions for analysis included the verb and the three following regions, i.e., words, (V+1, V+2, and V+3).

At the verb, there was a significant main effect of ELLIPSIS. The ellipsis condition was read more slowly overall. The main effect of GRAMMATICALITY approached significance; ungrammatical conditions were read more slowly. At the V+1 region, there were two interactions: ELLIPSIS with ATTRACTOR and ATTRACTOR with GRAMMATICALITY. Conditions with plural attractors were read more slowly when there is no

ellipsis. Ungrammatical conditions with plural attractors were read faster than ungrammatical conditions with singular attractors. At V+2, there was a main effect of attractor; plural attractor conditions are read more quickly overall. At V+3, the interaction of ATTRACTOR with ELLIPSIS approached significance; plural attractor conditions were read more quickly in the ELLIPSIS condition.

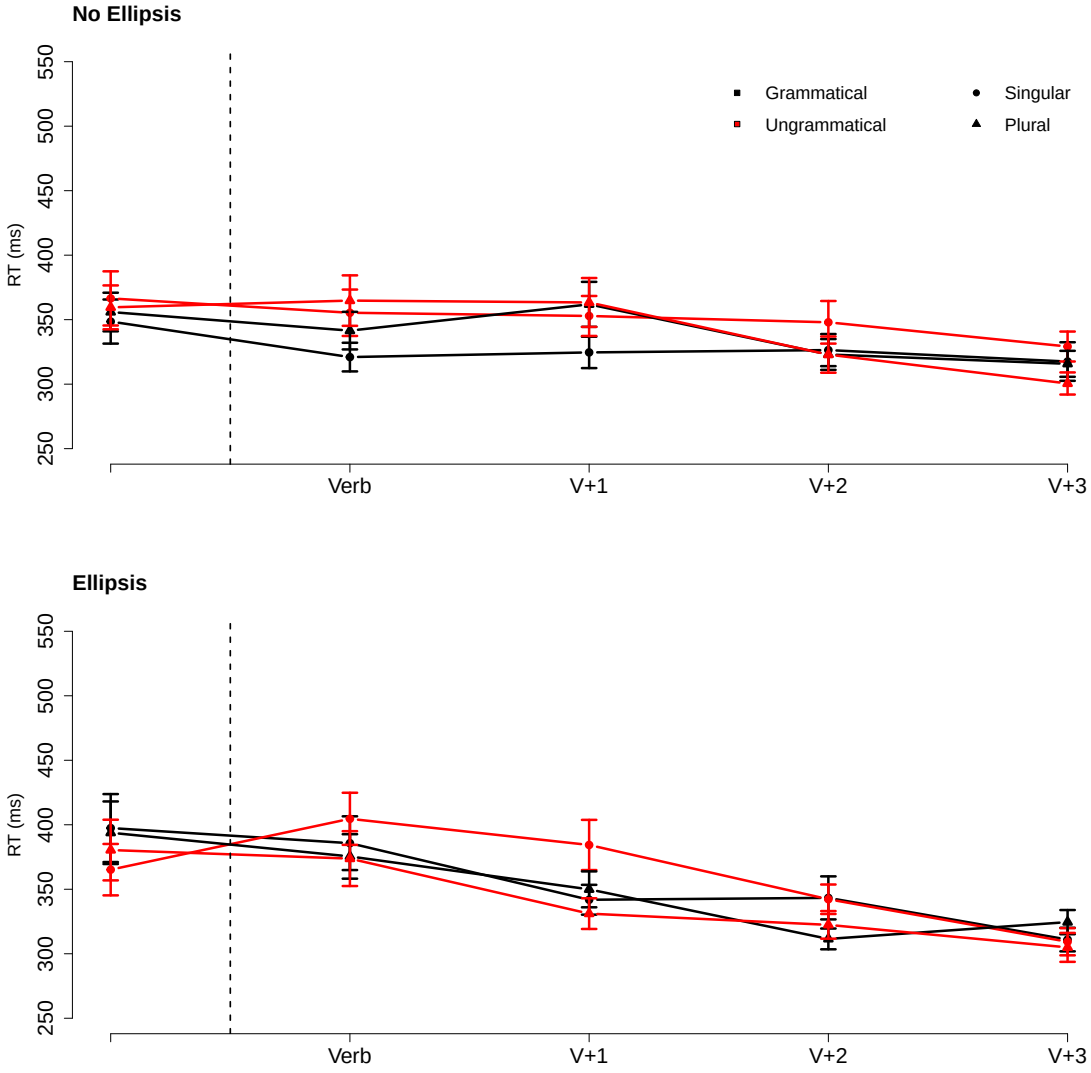


Figure 8: Self-paced reading results of Experiment 4, NO ELLIPSIS (Top) & ELLIPSIS (Bottom). Region by region means by ATTRACTOR and GRAMMATICALITY. Error bars indicate standard error of the mean.
Sample: . . . was/were$_{\text{Verb}}$ at$_{\text{V+1}}$ the$_{\text{V+2}}$ office$_{\text{V+3}}$

Table 21: Mixed-effect model coefficient table for Experiment 4.
Bold values indicate statistical significance

		β	SE	t	p	
Verb						
	Attractor	-3.67	11.48	-0.32	0.74	
	Grammaticality	20.67	11.76	1.75	0.08	.
	Ellipsis	**34.51**	**10.65**	**3.24**	**0.001**	**
	Attractor × Grammaticality	-10.27	29.01	-0.35	0.72	
	Attractor × Ellipsis	-26.36	21.28	-1.23	0.21	
	Grammaticality × Ellipsis	-22.10	21.26	-1.03	0.29	
	Attractor × Gramm. × Ellipsis	-6.54	42.70	-0.15	0.87	
V + 1						
	Attractor	0.54	9.07	0.06	0.95	
	Grammaticality	12.77	10.28	1.24	0.21	
	Ellipsis	-1.94	8.98	-0.21	0.82	
	Attractor × Grammaticality	**-37.87**	**19.51**	**-1.94**	**0.04**	*
	Attractor × Ellipsis	**-45.15**	**17.98**	**-2.51**	**0.01**	*
	Grammaticality × Ellipsis	-8.29	17.96	-0.46	0.64	
	Attractor × Gramm. × Ellipsis	-28.84	36.06	-0.81	0.42	
V + 2						
	Attractor	**-18.79**	**8.17**	**-2.29**	**0.02**	*
	Grammaticality	7.51	9.07	0.82	0.41	
	Ellipsis	-2.80	7.70	-0.36	0.71	
	Attractor × Grammaticality	1.87	16.78	0.11	0.91	
	Attractor × Ellipsis	-6.61	15.43	-0.42	0.66	
	Grammaticality × Ellipsis	-10.64	15.40	-0.69	0.48	
	Attractor × Gramm. × Ellipsis	40.74	30.93	1.31	0.18	
V + 3						
	Attractor	-5.71	6.94	-0.82	0.41	
	Grammaticality	-4.42	6.73	-0.65	0.51	
	Ellipsis	-5.91	6.21	-0.95	0.34	
	Attractor × Grammaticality	-17.32	15.61	-1.11	0.27	
	Attractor × Ellipsis	21.53	12.39	1.73	0.08	.
	Grammaticality × Ellipsis	-10.56	12.38	-0.85	0.39	
	Attractor × Gramm. × Ellipsis	9.73	24.84	0.39	0.69	

Table 22: Means for Experiment 4 by region.

ELLIPSIS	GRAM.	ATTR.	V	V+1	V+2	V+3
NE	G	SG	321	325	326	318
NE	G	PL	341	362	323	316
NE	UG	SG	355	353	348	329
NE	UG	PL	365	363	323	301
E	G	SG	386	342	343	311
E	G	PL	375	350	312	325
E	UG	SG	405	384	342	309
E	UG	PL	374	331	322	305

Ellipsis

At the verb, there were no significant effects. At V+1, there was a main effect of ATTRACTOR which approached significance; plural attractors were read more slowly. There was also an interaction of ATTRACTOR with GRAMMATICALITY; ungrammatical conditions with plural attractors were read faster than ungrammatical conditions with singular attractors. At V+2, there was a main effect of ATTRACTOR; conditions with plural attractors were read more quickly.

No Ellipsis

At the verb, there was a main effect of GRAMMATICALITY; ungrammatical conditions were read more slowly. At V+1, the main effect of ATTRACTOR approached significance; plural attractor conditions were read more slowly overall.

Table 23: Mixed-effect model coefficient table for Experiment 4, split by ELLIPSIS factor. Bold values indicate statistical significance.

		ELLIPSIS					NO ELLIPSIS				
		β	SE	t	p		β	SE	t	p	
Verb											
	Attractor	-19.61	17.09	-1.14	0.25		10.40	13.86	0.75	0.45	
	Gram	15.84	17.13	0.92	0.35		32.29	13.92	2.31	0.02	**
	A×G	-11.38	34.16	-0.33	0.73		-7.82	27.89	-0.28	0.77	
V+1											
	Attractor	-21.13	12.29	-1.72	0.08	.	**24.01**	**13.80**	**1.73**	**0.08**	·
	Gram	10.18	12.32	0.82	0.41		18.33	13.87	1.32	0.18	
	A×G	-52.74	24.56	-2.14	0.03	*	-33.55	27.80	-1.20	0.22	
V+2											
	Attractor	-23.91	10.53	-2.26	0.02	*	-17.46	11.77	-1.48	0.13	
	Gram	4.108	10.56	0.38	0.69		14.21	11.83	1.21	0.23	
	A×G	21.84	21.06	1.03	0.31		-19.55	23.69	-0.82	0.41	
V+3											
	Attractor	4.93	8.41	0.58	0.55		-16.67	9.66	-1.72	0.08	.
	Gram	-10.77	8.42	-1.27	0.21		0.69	9.71	0.07	0.94	
	A×G	-11.97	16.79	-0.71	0.47		-23.37	19.42	-1.23	0.22	

Table 24: Mixed-effect model coefficient table for Experiment 4, subset by Ellipsis Site Location (Non-Subordinate/Subordinate). Bold values indicate statistical significance.

		NON-SUBORDINATE					SUBORDINATE				
		β	SE	t	p		β	SE	t	p	
Verb											
	Attr.	7.93	16.69	0.47	0.63		-12.64	13.59	-0.92	0.35	
	Gram.	**27.68**	**16.73**	**1.65**	**0.09**	·	12.76	13.89	-0.92	0.35	
	Ell.	**64.42**	**16.58**	**3.88**	**0.00**	***	6.47	13.59	0.91	0.63	
	A×G	6.39	33.28	0.19	0.84		-44.77	27.66	-1.61	0.10	
	A×E	-43.23	33.20	-1.30	0.19		-8.33	27.14	-0.30	0.75	
	G×E	-35.39	33.20	-1.06	0.28		-4.47	27.10	-0.16	0.86	
	A×G×E	-37.06	66.48	-0.55	0.57		16.39	54.48	0.30	0.76	
V+1											
	Attr.	13.83	11.59	1.19	0.23		-21.59	11.32	-1.91	0.05	.
	Gram.	8.13	11.63	0.69	0.48		0.98	11.57	0.08	0.93	
	Ell.	2.49	11.52	0.21	0.82		-10.62	11.32	-0.93	0.34	
	A×G	-18.50	23.13	-0.79	0.42		21.31	23.05	0.92	0.35	
	A×E	**-56.90**	**23.07**	**-2.46**	**< 0.05**	*	0.41	22.61	0.01	0.98	
	G×E	**-51.17**	**23.07**	**-2.21**	**< 0.05**	*	14.04	22.57	0.62	0.53	
	A×G×E	-28.06	46.20	-0.60	0.54		44.05	45.38	0.97	0.33	
V+2											
	Attr.	**-22.21**	**10.69**	**-2.07**	**< 0.05**	*	-21.59	11.32	-1.91	0.05	.
	Gram.	**18.16**	**10.72**	**1.69**	**0.09**	·	0.98	11.57	0.08	0.93	
	Ell.	5.96	10.63	0.45	0.57		-10.62	11.32	-0.93	0.34	
	A×G	-7.67	21.33	-0.35	0.71		21.31	23.05	0.92	0.35	
	A×E	-19.18	21.29	0.36			0.41	22.61	0.01	0.98	
	G×E	-30.24	21.28	-1.14	0.15		14.04	22.57	0.62	0.53	
	A×G×E	28.39	42.60	0.66	0.50		44.05	45.38	0.97	0.33	
V+3											
	Attr.	**-18.26**	**9.60**	**-1.90**	**0.05**	·	5.91	8.43	0.71	0.48	
	Gram.	-1.59	9.63	-0.12	0.86		-6.91	8.66	-0.79	0.42	
	Ell.	0.23	19.16	-0.50	0.61		-11.67	8.41	-1.38	0.16	
	A×G	-9.59	19.16	-0.50	0.61		-23.78	17.22	-1.38	0.16	
	A×E	0.37	19.12	0.01	0.98		39.12	16.78	2.33	0.02	*
	G×E	-4.57	19.12	-0.23	0.81		-14.11	16.76	-0.84	0.41	
	A×G×E	-29.06	38.27	-0.75	0.44		53.81	33.66	1.59	0.11	

Table 25: Means for Experiment 4 by region, subset by Ellipsis Site Location (Non-Subordinate/Subordinate).

			NON-SUBORDINATE				SUBORDINATE			
Ellip.	Attr.	Gramm.	V	V+1	V+2	V+3	V	V+1	V+2	V+3
NE	G	SG	313	309	307	319	330	342	348	316
NE	G	PL	320	346	303	293	363	378	343	339
NE	UG	SG	333	331	343	312	380	378	354	349
NE	UG	PL	393	386	329	302	332	337	316	299
E	G	SG	419	359	346	317	348	322	340	304
E	G	PL	397	360	310	309	356	341	313	339
E	UG	SG	419	355	342	321	391	413	343	297
E	UG	PL	403	325	318	295	342	338	327	316

Non-Subordinate

At the verb, there was a significant main effect of ELLIPSIS; the ellipsis condition was read more slowly overall than the non-ellipsis condition. GRAMMATICALITY approached significance; ungrammatical conditions were read more slowly. At V+1, both ATTRACTOR and GRAMMATICALITY intacted significantly with ELLIPSIS. Plural attractors were read more slowly when in the no ellipsis condition. Ungrammatical conditions were read more slowly in the no ellipsis condition. At V+2, the main effect of ATTRACTOR was significant; plural attractor conditions were read faster. The main effect of GRAMMATICALITY approached significance; ungrammatical conditions were read more slowly. At V+3, the ATTRACTOR approached significance, with the same pattern.

Subordinate

At V+1, the main effect of ATTRACTOR approached significance; plural attractor conditions were read more quickly. This effect persisted in V+2 with the same pattern, and again only approached significance. At V+3, there was a significant interaction of ATTRACTOR with ELLIPSIS;plural attractor conditions were read more slowly in the Ellipsis condition.

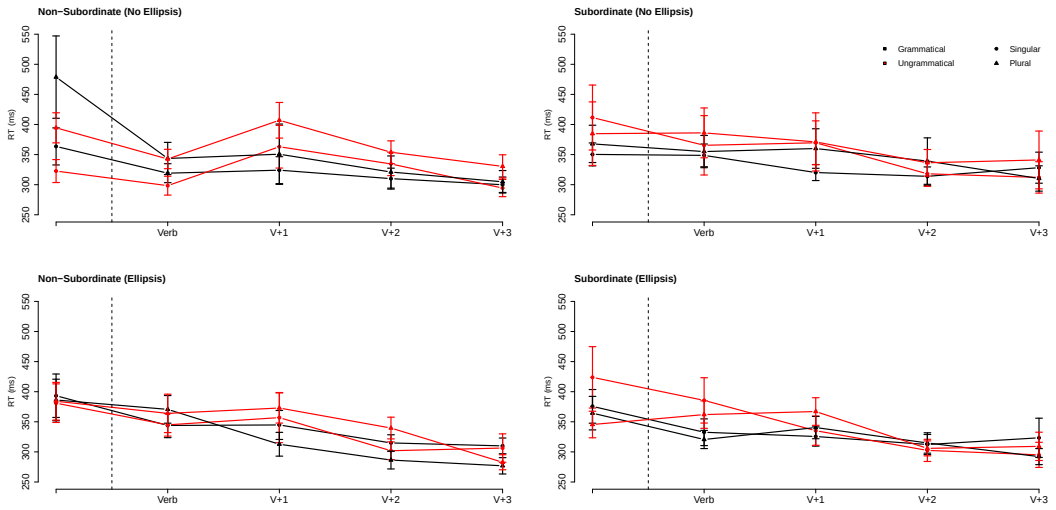


Figure 9: Self-paced reading results of Experiment 4, NO ELLIPSIS (Top) & ELLIPSIS (Bottom), subset by Ellipsis Site Location: Non-Subordinate (Left), Subordinate (Right). Region by region means by ATTRACTOR and GRAMMATICALITY. Error bars indicate standard error of the mean. Sample: . . . *was/were*$_{Verb}$ *at*$_{V+1}$ *the*$_{V+2}$ *office*$_{V+3}$

3.4.5 Discussion

The goal of Experiment 4 was to see if when only the attractor is elided, agreement attraction occurs. The data support that when the attractor is elided, agreement attraction *does* occur. At V+1, the critical effect emerges as significant; ungrammatical conditions with plural attractors were read more quickly than those with singular attractors. Further, the attraction interaction effect was supported by the speed up for plurals occurring in both the V+1 and V+2 regions. There was also a significant interaction of ATTRACTOR with ELLIPSIS at V+1 and V+3. Here, even without a split analysis, it is clear that the attraction effects are present only within the ellipsis data; the speed up for plural attractor conditions is present only within the Ellipsis data. While the effect of ATTRACTOR in later regions is that plural conditions are read more quickly, initially at the verb, there is a main effect of ATTRACTOR is in the other direction; plural attractors were read more slowly. In previous attraction experiments (without ellipsis), the initial effect of plural attractors being read longer is analyzed as being due to the additional complexity of reading the plural as opposed to the singular. Increased difficulty could

be due to plural semantics, the addition of morphology, or simply due to a difference in length (Wagers et al., 2009). This explanation would hold for the No Ellipsis condition, but not for the Ellipsis condition, as there is no overt material. Potentially, though, this same explanation could be extended to Ellipsis. Here, it is only the head that may be reactivated; the only difference between the reactivated pieces of structure might be the difference between singular and plural. The reactivation of a more complex structure, like the plural, may take longer than the singular, which results in the increased reading times for the plural conditions.

Ellipsis vs. No Ellipsis

The data were split by the ELLIPSIS factor in order to analyze the Ellipsis condition separately from the No Ellipsis condition. This split makes clear that the attraction effects that arise are, in fact, driven by the Ellipsis data (i.e., reactivation) rather than attraction which may take place at a distance. Within the Ellipsis data, the critical agreement attraction interaction emerged as significant, and was supported by plural attractor conditions being read more quickly overall at both the region where the interaction occurs and the region following. Within the Ellipsis data, perhaps surprisingly, it emerged that plural attractors were initially read more slowly. This is expected for No Ellipsis, but is not, necessarily, for the Ellipsis data. Following the logic above, as it is only the head that needs to be reactivated, perhaps the reactivation of a more complex constituent, like a plural, results in slower, initial reading times than the singular.

In the No Ellipsis data, there were no effects of attraction, long distance or otherwise. There is a predicted effect of GRAMMATICALITY and seemingly no potential for attraction as plural attractor conditions continue to be read more slowly than their singular attractor counterparts.

Non-Subordinate vs. Subordinate

For the Non-Subordinate data, overall, in the No Ellipsis condition, both the plural and ungrammatical conditions are read the slowest—there are no effects, or even suggestive effects, of attraction. Within the Ellipsis data, there is a speed up for plurals, which

is suggestive of attraction, but the effect is not significant. The effects which interact with ELLIPSIS, both ATTRACTOR and GRAMMATICALITY, indicate cost for plural conditions and ungrammatical conditions in the No Ellipsis data, and only the suggestive speed up for Ellipsis Conditions, rather than the full interaction, emerges.

Within the Subordinate data, the ATTRACTOR effects only approach significance, but these effects are in the direction that is suggestive of attraction. In the final region (V+3), the ATTRACTOR effect interacted with ELLIPSIS, however, here the plural attraction conditions were read more slowly.

The Non-Subordinate data do not suggest that there is any attraction, nor the suggestion of attraction. In the Subordinate data, the speed up for the plural attractors is indicative of attraction, though, these effects do not emerge as significant. Impressionistically, attraction appears to be trending in the Ellipsis data, but for only the Subordinate data.

Experiment 4 successfully illustrated that when only the attractor is elided, agreement attraction effects can be seen in the post-elliptical region. Within this experiment, there was no long distance attraction. The agreement attraction effects that were seen (either the interaction indicative of attraction or the suggestive speed up for the plural attractor conditions) were found to be located within the Ellipsis data alone, and further, only within the Subordinate data. This experiment provides evidence for both partial reactivation and for a syntactic representation, due to the sensitivity, as evidence by successful attraction, to the reactivated plural number feature.

4 General Discussion

The present study aimed to investigate the nature of the representation reactivated at ellipsis sites. Experiment 1 served as a baseline. The nominals used do, indeed, generate agreement attraction. Additionally, derived nominals seemed to generate larger effects than nominals, though the nominals also trend towards attraction. Experiment 2 elided the entire attraction-triggering nominal in bi-clausal sentences using causal and contrastive connective. Agreement attraction was significant, but across both Ellipsis and No Ellipsis conditions; this provided evidence for long-distance attraction. When splitting the analysis based on the Ellipsis factor, only Grammaticality effects found. This was explained via partial reactivation, i.e., only the head is reactivated. There was also a non-significant, though trending, effect of attraction in the final region. At this region, there was no long-distance attraction, however, this effect could either be from reactivation, long-distance attraction, or the combination of the two. Again, the derived nominals seemed to drive the effects. In Experiment 3, materials consisted of bi-clausal sentences, this time joined with temporal subordinators. There was no long-distance attraction and no difference between the derived nominals and nominals. As in Experiment 2, there were only significant Grammaticality effects, further supporting partial reactivation. There was, however, one instance which was suggestive of Attraction, which arose in the Non-Subordinated subset of the data in the final region. Experiment 4 investigated the claim of partial reaction by eliding only a head—the attractor. Materials were bi-clausal and joined with temporal subordinators. Agreement attraction was significant in only the ellipsis data. There was no long-distance attraction. Contra Experiment 3, here the effects appeared only within the Subordinate data, not the Non-Subordinate data.

The table below summarizes the results of the four experiments presented here.

Table 26: Summary of experimental results, Experiments 1-4.

	Attraction	L-D Attraction	Joined W/	Head Type	Clause Location
Experiment 1	✓	NA	NA	Der	NA
Experiment 2	✓	✓	Cause	Der	NA
Experiment 3	✗	✗	Temp	Both	Fronted
Experiment 4	✓	✗	Temp	NA	Sub

From these experiments the following claims can be made: derived nominals seem to more strongly drive attraction effects (1-2); reactivated materials at ellipsis sites in sensitive to morpho-syntactic number features (2-4); reactivation at ellipsis sites is partial (2-3); clausal relations that are causal allow for long-distance attraction (2). The following claims, and implications of these claims, are explored in the discussion below.

Partial Reactivation at Ellipsis Sites

In Experiments 2 & 3, where the entire attraction-triggering nominal is elided, there are only significant effects of GRAMMATICALITY and no interaction of ATTRACTOR with GRAMMATICALITY which would indicate attraction. The hypothesis was that reactivation would be full, and attraction effects would arise, but this was not the case. Rather than assuming that reactivated representations do not encode number features that can drive attraction (which Experiment 4 would invalidate), an explanation can be given by saying that the reactivation is only partial, and not full. Only the head of the nominal is reactivated under ellipsis, which gives rise to the GRAMMATICALITY effects, while also accounting for the lack of attraction effects.

However, recall that in Experiment 2 in the final analysis region, the agreement attraction pattern emerged in the means, but was not significant. In this same region of analysis across conditions, there was no long distance attraction, so potentially there is attraction here that is from the reactivated constituent. This would follow from the fact that reactivation may take more time, and its effects would emerge later. If this is

attraction, this is not captured under partial reactivation.

Within Experiment 3, also at the final region of analysis, there were non-significant effects that suggested attraction, but here, it was only the speed up for the plurals, not the agreement attraction pattern seen in Experiment 2. If the speed up for plurals is taken to be indicative of attraction, why this speed up occurs is not accounted for by partial reactivation. Within Experiment 3, these effects can't be relegated to long distance attraction, because (as argued below), the temporal subordinators used do not allow for long distance attraction; these effects were from the reactivated representation. Again, this is not explained under a view from partial reactivation.

An alternative explanation is that the full structure is reactivated, but that various other factors serve to inhibit the possibility of attraction. This would explain the effects that approach significance, that in looking at the pattern with the means, seems to suggest attraction. First, consider that across all cases, these attraction-triggering nominals are housed within a possessive structure. While Experiment 1 illustrated that attraction is still possible from this configuration, perhaps the increase in distance does slightly diminish the effect. It is also plausible to think that reactivated cues will not be as strong. Evidence from Experiments 2, 3, 4 show that when the relation between clauses is temporal, long distance attraction can not occur (the motivation for why is discussed below). In Experiment 3, there are the effects of surrounding structure, ellipsis, and lack of long distance attraction, that all work against the appearance of the attraction effect.

Under a full reactivation account, the difference in the pattern between Experiment 2 and Experiment 3 hinges on the difference in clausal relations, which either allow or disallow long distance attraction. Attraction emerges as significant in Experiment 2 due to the additive effects of long distance attraction and attraction generated from reactivation. Reactivation is assumed to partially contribute here since the attraction effect does emerge in the final region of analysis. This effect occurred where long distance attraction was seemingly not occurring, and further, it is not surprising that the

effects of reactivated constituents may appear later, as reactivation takes some time.

The lack of attraction effects in Experiment 3 were due to this ganging up of factors that inhibit attraction. However, this still allows the reason for the plural speed up to be explained—attraction is dampened from emerging significantly, but the plural is still accessible, giving rise to this speed up. Thus, a story of full reactivation which can be inhibited explains the pattern of data in Experiments 2 & 3, and accounts for the effects which trend towards attraction, which a theory of partial reactivation may not be able to explain.

However, an explanation appealing to full reactivation hinges upon the need to explain a few, non-significant, and really only suggestive effects. At present, the data more strongly support a theory of partial reactivation. A point to take away, though, is that perhaps reactivation is sensitive to far more factors than had previously been thought.

Sensitivity to Number Features

All three experiments that contained an ELLIPSIS condition exhibited sensitivity to number features. In Experiments 2 & 3, there were significant effects of GRAMMATICALITY; ungrammatical conditions were read more slowly than grammatical conditions. These effects occurred within both the Ellipsis and No Ellipsis data. In the No Ellipsis data, this is unsurprising; there is only a singular subject available. Within the Ellipsis data, the sensitivity to the ungrammaticality must arise from the reactivation of *at least* the singular features of the head, otherwise, there would be no effect of grammaticality. Experiment 4 also illustrates sensitivity to number features; the reactivated, plural number features are strong enough to give rise to attract effects. These effects arise from access to number features must mean that number features are present within the reactivated representation. If number features are considered to be morpho-syntactic, then this suggests that the representation is syntactic, or at least something that encodes number features.

In combining the claims that reactivation is partial, i.e., only the head is reactivated,

with the claim that the the reactivated head does encode number features, the results from Experiment 3 support a content-addressable view of agreement attraction, rather than a syntactic, percolation mechanism. Under a percolation view, the head contains both the singular and plural features. Attraction arises as either of these features are available. If only the head is reactivated and that head contained both singular and plural features, attraction should be possible. However, in Experiment 3 where there is no effect of long-distance attraction and there is ellipsis, no attraction effects are found. This provides evidence for the claim that reactivation is partial and that the reactivated head must not contain the plural feature. If, however, there is full reactivation, this does not necessarily provide evidence against a percolation account. Given the conclusion above that the data more readily support a partial reactivation, it seems fair to also argue in favor of content-addressability.

Long Distance Attraction and Causal/Temporal Subordinators

An interesting result that emerged is that the possibility for long-distance attraction is modulated by the connective that is used. Using these difference connectives, e.g., causal/contrastive subordinators or temporal subordinators, changes the discourse relations that may hold between clauses. The pattern that emerges from Experiments 2-4 is the following: long distance attraction occurs in Experiment 2 when joined with causal subordinators, in Experiment 3, with temporal subordinators, there is no attraction and no long distance attraction (though no attraction could be due to inhibiting effects), and in Experiment 4, with temporal subordinators, attraction CAN occurs, but there are no long distance effects. This final experiment illustrates that it's not the case that temporal connectives remove the possibility for attraction entirely, just long distance attraction.

Why might the difference in relation between clauses that allow or disallow attraction? The causal/contrastive subordinators could more closely link the two clauses. If there is a cause-effect relationship, or contrast between two clauses, this could suggest that the clauses together are jointly expressing something, and as such, perhaps the

same possible referents remain active across the two clauses. This would then allow the plural attractor to be accessible, even within the second clause where it is non-local. In the case of the temporal subordinators, while the clauses are oriented with respect to each other, i.e., the timing of the events, they are not at dependent on each other in any way. Here, potentially the referents that are available are only those within the local clause. Only when there is a dependent relation between clauses, like cause-effect, do referents from a non-local clause become available. This accounts for why long-distance attraction is blocked in Experiments 3-4, but available in Experiment 2.

Non-Subordinated vs. Subordinated

Experiments 3 & 4 diverged as to where the effects of attraction appeared. Both experiments had the same clausal relation; they were joined with temporal subordinators, so this offers no explanation. The only difference between the experiments was the size of the reactivated constituent, however, this also doesn't offer any explanation. In Experiment 3 the whole nominal was available for reactivation and the effects arose in the Non-Subordinate data whereas in Experiment 4, only the attractor was available and the effects arose in the Subordinate data. In Experiment 3, it is not the interaction which emerges as significant, but rather there is only the speed up for the plural attractor condition that suggest attraction. However, Experiment 4 illustrates true, not suggestive, and significant, effects of attraction. In Experiment 4, the Non-Subordinate data in later regions did exhibit the speed up for the plurals, just as in Experiment 3. Only in Experiment 4, though, did the attraction effect reach significance, and only in the subordinated data. This effect may not have emerged in Experiment 3 as this configuration could strongly hider reactivation, inhibiting attraction.

Given this explanation, Experiments 3 & 4 have the same pattern: there is a speed up for the plural attractor condition in the final analysis region for the Non-Subordinate data and the Subordinate data is where attraction effects will emerge, but in Experiment 3, this is dampened by multiple factors such that it does not arise at all.

Derived Nouns vs. Simple Nouns

Across Experiments 1 & 2, the derived nouns generated stronger effects. While the simple nouns do still generate effects, it's not that simple nouns are defective at generating attraction, there is something about the derived nouns which more strongly generates these effects. In the discussion of Experiment 1, an explanation from processing was explored.

Impressionistically, it seemed as though reading times for sentences with derived nouns were slower within the regions of analysis; this suggests additional difficulty when reading the derived nouns which persists into these later regions. At the regions where the derived nouns and simple nouns were read, in both experiments the derived nouns were read more slowly. When material is read more slowly, this often indicates that there is difficulty; it's plausible that the structure of the derived noun is more difficult than that of the simple nouns. If the material is more deeply processed, perhaps it is more deeply encoded, driving more robust effects. This argument follows for Experiment 2, where the long distance attraction occurs; the long distance effects were driven by the derived nouns—which were read slower, and the same pattern holds. However, here it is difficult to tease apart if the robust attraction effects that arose were from long distance attraction, reactivation, or a combination of the two. If the attraction effects are due, in part, to the reactivated representation, potentially the additional processing due to the increased complexity and thus when retrieved, has more deeply or strongly encoded the crucial plural features.

An alternative explanation could appeal to the distinction between arguments and adjuncts with respect to their relation to a head. This may have an impact on the strength of the reactivation. For the simple nouns, some nouns are in an argument relationship and others an adjunct relationship, to the piece of structure that contains the attractor. For the derived nouns, the relationship is always that of an argument; there is a direct, head-to-head relation between the head noun and the attractor structure. If

the effects seen in the ellipsis data are in part due to the reactivated representation, this could explain the greater strength of the derived nouns. Perhaps the closer relation between the head and the attractor increases the likelihood for the structure in its entirety to be reactivated. For the simple nouns, the adjuncts may not be less strongly reactivated, which diminishes the possibility for them to generate strong attraction effects. Thus, derived nouns generate stronger effects than simple nouns outside of ellipsis due to depth of processing effects, and when elided, due to either depth of processing effects or the possibility that arguments are more likely to be reactivated than adjuncts.

5 Conclusion

This investigation has provided novel evidence about ellipsis and agreement attraction. The aim was to investigate the nature of the representation that was reactivated at ellipsis sites. The reactivated representation must be, in part, syntactic. The reactivated representation exhibits sensitivity to ungrammaticality (Experiments 2 & 3), i.e., sensitivity to mismatching features. Further, reactivated features can give rise to attraction effects (Experiment 4). If only the syntax contains morpho-syntactic number features, at least this portion of the syntax is made available when reactivated. Further, the results presented here implicate that reactivation may be partial—only the head is reactivated at ellipsis sites. Thus, the answer to the question about the nature of the ellipsis site is the following: the reactivated representation is syntactic and only the head of that structure is reactivated. An additional point arose regarding agreement attraction: it may occur across clauses, but this is modulated by the relation between clauses. Long-distance attraction is only possible when there is a causal relation between clauses, which could make parallelism more highly preferred. In light of the relational differences and the parallelism potentially instantiated, an alternative account appealing to full reactivation, instead of partial reactivation, was also explored. Attraction happened across all experiments, but was diminished by several factors, resulting in the lack of robust attraction effects. The final picture, though, that is supported more strongly by the data is that of partial, syntactic reactivation.

Appendix A

1. Harvey's memo from the architect{∅, s} {was, were} being scrutinized by the secretary.
2. Margaret's report from the manager{∅, s} {was, were} unable to boost morale at the office.
3. Michelle's note on the chart{∅, s} {was, were} able to aid the researchers in the meantime.
4. John's problem with the store{∅, s} {was, were} taken more seriously by the company the next day.
5. Lily's poster for the campaign{∅, s} {was, were} declared the winner of the contest by the principal.
6. Mitchell's crime in the suburb{∅, s} {was, were} reported to the police by the neighbors .
7. Henry's complaint about the student{∅, s} {was, were} discussed by the faculty at great length.
8. Emily's check from the stockbroker{∅, s} {was, were} declared fraudulent by the banker.
9. Harold's key to the room{∅, s} {was, were} able to be tracked down by the concierge.
10. Elise's picture on the flier{∅, s} {was, were} said to be more attractive in photographs.
11. Carl's book about the pilot{∅, s} {was, were} banned by the aviation association seemingly without reason.
12. Caroline's mistake on the program{∅, s} {was, were} criticized by the editor of the school newspaper.
13. Sean's advertisement for the candidate{∅, s} {was, were} seen on the jumbotron at the game.
14. Sadie's message to the director{∅, s} {was, were} considered very diplomatic and sincere.
15. Jack's letter to the editor{∅, s} {was, were} incomprehensible due to all the spelling errors.
16. Catherine's record of the incident{∅, s} {was, were} able to clarify the situation the next day.
17. Tom's praise of the beginner{∅, s} {was, were} able to validate the compliment in the report.

18. Martha's frustration with the administrator{∅, s} {was, were} supported by other board members in the meeting.

19. Patrick's distrust of the boss{∅, s} {was, were} caused by the rumors started at the office.

20. Rachel's commitment to the school{∅, s} {was, were} acknowledged with an award from the board.

21. Bob's engagement with the issue{∅, s} {was, were} rooted in caring for the community.

22. Charlotte's disobedience of the rule{∅, s} {was, were} not punished by the administration.

23. Christopher's support of the bill{∅, s} {was, were} questioned by the other senators.

24. Patricia's love for the pupil{∅, s} {was, were} recognized at the end of the year ceremony.

25. Jared's name on the advertisement{∅, s} {was, were} bringing the most customers into the store.

26. Clara's faith in the supervisor{∅, s} {was, were} restored after the management issued an apology.

27. Robert's examination of the patient{∅, s} {was, were} able to reveal the underlying problem.

28. Jenna's happiness for the employee{∅, s} {was, were} apparent in the end of the quarter speech.

29. Ronald's frustration with the teacher{∅, s} {was, were} disproportionate given the source of the disagreement.

30. Sally's admiration for the speaker{∅, s} {was, were} based on the stories from the autobiography.

31. Sarah's attention to the intern{∅, s} {was, were} misplaced as the current workers needed more help.

32. Jack's dependence on the medication{∅, s} {was, were} the topic of discussion among the nurses.

Appendix B

1. Harvey's slogan on the poster{∅, s} instilled fear but Frank{∅, 's} unsurprisingly {was, were} lacking inspiration despite his best attempts.
2. Michelle's mistake on the program{∅, s} caused problems but Kelly{∅, 's} luckily {was, were} not an issue during the performance.
3. John's problem with the store{∅, s} received attention but Otto{∅, 's} unfortunately {was, were} not taken seriously due to the incident.
4. Margaret's picture on the flier{∅, s} looked intimidating and Marilyn{∅, 's} apparently {was, were} very startling as well given her expression.
5. Lily's label on the container{∅, s} seemed clear but Mindy{∅, 's} however {was, were} not payed attention to even with her reminders.
6. Mitchell's name on the billboard{∅, s} looked garish and Owen{∅, 's} evidently {was, were} also an eyesore due to the bright pattern.
7. Dean's crime in the suburb{∅, s} incited riots but Kevin{∅, 's} shockingly {was, were} less newsworthy even if more impactful.
8. Emily's citation on the notecard{∅, s} looked incorrect but Lauren{∅, 's} luckily {was, were} very helpful in locating the book.
9. Harold's advertisement on the skyscraper{∅, s} got defaced but Steven{∅, 's} however {was, were} not worth bothering with since his resignation.
10. Beth's memo from the supervisor{∅, s} got lost while Audrey{∅, 's} conveniently {was, were} at the office across the way.
11. Carl's check from the stockbroker{∅, s} seemed legitimate though Tony{∅, 's} certainly {was, were} fake and caused a scene.
12. Caroline's message to the directer{∅, s} worried others but Rebecca{∅, 's} probably {was, were} no cause for alarm because of her position.
13. Sean's key to the room{∅, s} got bent but Michael{∅, 's} thankfully {was, were} in good shape after the accident on the freeway yesterday.
14. Jean's letter to the editor{∅, s} seemed uninformed but Mary{∅, 's} definitely {was, were} raising difficult and thoughtful questions.
15. Jack's warning from the expert{∅, s} caused distress while Jesse{∅, 's} doubtlessly {was, were} not even heeded due to his status.
16. Catherine's gift from the visitor{∅, s} looked ostentatious and Skylar{∅, 's} regrettably {was, were} gaudy as well and not appreciated.

17. Tom's message to the engineer{∅, s} appeared unreasonable but Dale{∅, 's} surely {was, were} making logical claims regarding company development.

18. Martha's note to the administrator{∅, s} seemed offensive and Jane{∅, 's} allegedly {was, were} exposing the company's problems after the market crash.

19. Patrick's complaint about the student{∅, s} raised concerns but Bill{∅, 's} fortunately {was, were} more unbiased about the situation.

20. Rachel's distaste for the manager{∅, s} seemed offensive though Amelia{∅, 's} certainly {was, were} far more rude, given her attitude.

21. Bob's distrust of the supervisor{∅, s} seemed warranted though Will{∅, 's} sadly {was, were} illustrating naivety and lack of experience.

22. Charlotte's disinterest in the student{∅, s} bothered administrators and Erica{∅, 's} surely {was, were} equally bothersome given her position.

23. Brandon's engagement with the issue{∅, s} caused upheaval though Allan{∅, 's} ultimately {was, were} far more involved.

24. Patricia's worry for the citizen{∅, s} illustrated empathy but Jill{∅, 's} however {was, were} just disguising her lack of trust.

25. Larry's concern for the baby{∅, s} showed compassion but Ben{∅, 's} possibly {was, were} only keeping up appearances for the guests.

26. Clara's fear of the snake{∅, s} caused panic but Maria{∅, 's} thankfully {was, were} kept under control by her coworkers.

27. Robert's praise for the intern{∅, s} appeared fake and Richard{∅, 's} similarly {was, were} not genuine despite their best intentions.

28. Jenna's anger towards the manager{∅, s} offended many though Lisa{∅, 's} shockingly {was, were} more aggressive in her display.

29. Ronald's report on the architect{∅, s} appeared disorganized but Andrew{∅, 's} fortunately {was, were} well organized and extremely prepared.

30. Sally's record of the incident{∅, s} sounded bizarre and Melissa{∅, 's} somehow {was, were} even more delusional and fairly convoluted.

31. Taylor's book about the pilot{∅, s} seemed positive but Sarah{∅, 's} unluckily {was, were} negative about the situation and the possible outcomes.

32. Kim's article about the executive{∅, s} caused controversy but Lexi{∅, 's} apparently {was, were} depicting a different side of

Appendix C

1. Before Harvey's memo from the architect{∅, s} could be found, Frank{∅, 's} surprisingly {was, were} being scrutinized by the secretary.
2. After Margaret's report from the manager{∅, s} caused budget cuts, Gwen{∅, 's} sadly {was, were} unable to boost morale at the office.
3. Before Michelle's note on the chart{∅, s} could be deciphered, Kelly{∅, 's} thankfully {was, were} able to aid the researchers in the meantime.
4. After John's problem with the store{∅, s} made the news, Otto{∅, 's} certainly {was, were} taken more seriously by the company the next day.
5. Lily's poster for the campaign{∅, s} got torn down after Annie{∅, 's} ultimately {was, were} declared the winner of the contest by the principal.
6. After Mitchell's crime in the suburb{∅, s} caused great distress, Owen{∅, 's} immediately {was, were} reported to the police by the neighbors .
7. As soon as Henry's complaint about the student{∅, s} surfaced, Kevin{∅, 's} apparently {was, were} discussed by the faculty at great length.
8. Before Emily's check from the stockbroker{∅, s} could be cashed, Lauren{∅, 's} regrettably {was, were} declared as a fraud by the banker.
9. Harold's key to the room{∅, s} got replaced even after Steven{∅, 's} luckily {was, were} able to be tracked down by the concierge.
10. Elise's picture on the flier{∅, s} got defaced right after Audrey{∅, 's} supposedly {was, were} said to be more attractive in photographs.
11. Carl's book about the pilot{∅, s} garnered significant attention after Tony{∅, 's} shockingly {was, were} banned by the aviation association seemingly without reason.
12. Caroline's mistake on the program{∅, s} went unnoticed even though Rebecca{∅, 's} previously {was, were} criticized by the editor for something similar.
13. Sean's advertisement for the candidate{∅, s} appeared overdone even before Michael{∅, 's} apparently {was, were} seen on the jumbotron at the game.
14. Sadie's message to the director{∅, s} seemed confrontational even before Mary{∅, 's} unsurprisingly {was, were} revealed as being very diplomatic and sincere.
15. Jack's letter to the editor{∅, s} clarified the issue after Malcolm{∅, 's} definitely {was, were} considered to be incomprehensible to the reader.
16. Catherine's record of the incident{∅, s} seemed poorly documented before Jennifer{∅, 's} luckily {was, were} able to clarify the situation the next day.

17. Tom's praise of the beginner{∅, s} seemed very undeserved until Dale{∅, 's} also {was, were} able to validate the compliment in the report.

18. Martha's anger towards the administrator{∅, s} caused great concern after Jane{∅, 's} actually {was, were} supported by other board members in the meeting.

19. Patrick's distrust of the boss{∅, s} worried employees even before Bill{∅, 's} evidently {was, were} starting rumors at the office about him.

20. Rachel's commitment to the school{∅, s} boosted scores even though Amelia{∅, 's} however {was, were} credited with the achievement by the board.

21. Bob's engagement with the issue{∅, s} appeared self serving after Will{∅, 's} clearly {was, were} focused on community outreach and development.

22. Charlotte's disobedience of the rule{∅, s} got ignored as after Erica{∅, 's} clearly {was, were} not punished by the administration.

23. Christopher's interest in the candidate{∅, s} became clear even before Allan{∅, 's} ultimately {was, were} questioned on his stance.

24. Patricia's love for the pupil{∅, s} went completely unnoticed after Jill{∅, 's} somehow {was, were} recognized with the award instead.

25. Even before Jared's name on the advertisement{∅, s} got removed, Ben{∅, 's} doubtlessly {was, were}bringing in the most customers to the store.

26. Even after Clara's trust in the supervisor{∅, s} got broken, Maria{∅, 's} fortunately {was, were} reinstated by the management almost immediately.

27. Earlier when Robert's examination of the patient{∅, s} revealed nothing, Richard{∅, 's} actually {was, were} able to diagnose the disease with ease.

28. Even after Jenna's happiness for the employee{∅, s} completely dissipated, Lisa{∅, 's} thankfully {was, were} reinvigorated by the positive and supportive environment.

29. Even before Ronald's frustration with the teacher{∅, s} became unreasonable, Harry{∅, 's} similarly {was, were} also out of control after their argument.

30. As soon as Sally's admiration for the speaker{∅, s} increased, Melissa{∅, 's} immediately {was, were} challenged by the journalist with an opposing viewpoint.

31. As soon as Sarah's attention to the intern{∅, s} increased, Kelsey{∅, 's} evidently {was, were} no longer seen as useful to the program.

32. After Jack's dependence on the medication{∅, s} interfered with work, Mark{∅, 's} surely {was, were} confronted in the meeting about the issue.

Appendix D

1. Before the memo from Harvey's architect{∅, s} could be found, the report from Frank{∅, 's} accidentally {was, were} sent to the engineer for review on Monday.

2. After the statement from Margaret's manager {∅, s}caused budget cuts, the letter from Gwen{∅, 's} lamentably {was, were} unable to boost morale at the office.

3. Before the writing on Michelle's note{∅, s} could be deciphered, the recommendation from Kelly{∅, 's} luckily {was, were} able to aid the doctor in the meantime.

4. After the problem with John's store{∅, s} made the news, the issue with Otto{∅, 's} certainly {was, were} taken more seriously by the investigators.

5. The poster for Lily's campaign{∅, s} got torn down, after the design by Annie{∅, 's} sadly {was, were} declared the loser of the design contest.

6. After the crime in Mitchell's district{∅, s} caused great distress, the robbery near Owen{∅, 's} undoubtedly {was, were} investigated by the police the next week.

7. As soon as the complaint about Henry's student{∅, s} surfaced, the frustration with Kevin{∅, 's} similarly {was, were} voiced by the other faculty members.

8. Before the check from Emily's benefactor{∅, s} could be cashed, the money from Lauren{∅, 's} mysteriously {was, were} moved out of the account on accident.

9. The key to Harold's room{∅, s} got replaced, even after the corridor by Steven{∅, 's} surely {was, were} cleared by the police after the break-in.

10. The picture on Elise's flier {∅, s}got defaced right after the design by Audrey{∅, 's} ostensibly {was, were} announced as the winner of the contest.

11. The book about Carl's brother{∅, s} received significant attention after the review by Tony{∅, 's} likely {was, were} heard on the national broadcast.

12. The mistake in Caroline's article{∅, s} went unnoticed, even though the error by Rebecca{∅, 's} definitely {was, were} criticized by the editor.

13. The advertisement for Sean's product {∅, s}appeared overdone even before the sketch by Michael{∅, 's} apparently {was, were} praised for having a minimalist design.

14. The message to Sadie's director{∅, s} seemed confrontational, especially after the email from Mary{∅, 's} suddenly {was, were} sent out regarding etiquette.

15. The letter to Jim's editor{∅, s} clarified the misprint after the message from Malcolm{∅, 's} unfortunately {was, were} published incorrectly.

16. The record of Catherine's account{∅, s} seemed fraudulent, even before the warning from Jenny{∅, 's} unexpectedly {was, were} received the next day.

17. The praise for Tom's apprentice{∅, s} seemed undeserved, until finally the criticism of Dale{∅, 's} evidently {was, were} discussed in the meeting.

18. The frustration with Martha's supervisor{∅, s} continued to grow, after the comment from Jane{∅, 's} regrettably {was, were} overheard in the staff room.

19. The anger towards Patrick's boss{∅, s} worried employees, even before the letter from Bill{∅, 's} shockingly {was, were} starting rumors at the office.

20. The funding for Rachel's project{∅, s} got denied even before the funding for Amelia{∅, 's} fortunately {was, were} supplemented for the next year.

21. The statement from Bob's partner{∅, s} sounded suspicious especially after the account from Will{∅, 's} ultimately {was, were} corroborated by another witness.

22. The disinterest in Charlotte's performance{∅, s} seemed very apparent after the applause for Erica{∅, 's} shockingly {was, were} heard even from outside.

23. The growing interest in Christopher's experiment{∅, s} declined immediately after the result from Allan{∅, 's} finally {was, were} recognized as being superior.

24. The success of Patricia's pupil{∅, s} went completely unnoticed after the effort by Jill{∅, 's} mistakenly {was, were} recognized with the award instead.

25. Even before the promotion on Jared's flier{∅, s} had ended, the advertisement from Ben{∅, 's} unsurprisingly {was, were} bringing more customers into the store.

26. Even after the confidence in Clara's supervisor{∅, s} had risen, the trust in Maria{∅, 's} absolutely {was, were} broken due to her dishonesty.

27. Earlier when the examination of Robert's patient{∅, s} revealed nothing, the report on Richard{∅, 's} thankfully {was, were} able to provide a useful clue.

28. Even after the happiness for Jenna's employee{∅, s} had faded, the anger towards Lisa{∅, 's} absolutely {was, were} still noticeable at the office.

29. Even before the argument with Sid's teacher{∅, s} became heated, the complaint from Harry{∅, 's} clearly {was, were} frustrating the school in general.

30. As soon as the admiration for Sally's achievement{∅, s} decreased, the argument about Melissa{∅, 's} surprisingly {was, were} the main topic of discussion.

31. As soon as the interest in Sarah's intern{∅, s} increased, the investment in Kelsey{∅, 's} regrettably {was, were} no longer seen as useful to the program.

32. Before the addendum to Jack's contract{∅, s} had been approved, the problem with Michael{∅, 's} thankfully {was, were} resolved by the accounting department.

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