RESEARCH

Repair or accommodation? Split antecedent ellipsis and the limits of repair

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We begin from the assumption that the grammar requires syntactic matching between an elided verb phrase (VP) and its antecedent. When a fully matching antecedent cannot be found, the antecedent will be repaired if there is evidence for the repair, only a few operations are needed, and the repair reverses a natural speech error. This view correctly predicts that acceptability judgements are inversely correlated with the degree of difficulty of the repair (Arregui et al. 2006; Frazier 2013) and lower when a repair is required than when it is not (Kim & Runner 2018; Clifton et al. 2019), for example.

Split antecedent ellipsis looks like a proto-typical case of repair since by definition no matching antecedent is available. It will be argued, however, that split antecedent ellipsis does not involve repair. The results of several experiments show that split antecedent ellipsis does not exhibit the hallmarks of repair. Rather it may involve ordinary accommodation. This raises the question of when the processor repairs an input and when it merely accommodates an antecedent of the appropriate type. We suggest that repair to a grammatical form is unavailable for split antecedent ellipsis because syntactic representation is only reliably available for the last independent clause.

1 Introduction

How can we account for the processing and distribution of verb phrase (VP) ellipsis structures? (See Johnson 1996; 2001; Kehler 2000; Merchant 2015; and Kobele & Merchant 2016 for discussion of the space of possibilities.) Here we assume that it is a theory of grammar together with a theory of processing that, taken jointly, accounts for actual data such as the acceptability and interpretation of elided constituents. We assume that the grammar requires syntactic matching of antecedent and elided constituent. This assumption is supported by the systematic finding of a strong decrement in acceptability for antecedent clauses which mismatch an ellipsis clause with no corresponding decrement in acceptability for the full counterparts of the ellipsis examples (Kim & Runner 2018; Clifton et al. 2019; see Kim et al. 2011 for a different account of the mismatch penalty). Following Arregui et al. (2006) and subsequent work (e.g., Frazier & Clifton 2015), the processor repairs a syntactic antecedent that nearly matches the elided constituent syntactically if the repair is a simple and natural one, i.e., one with few operations, lots of evidence for those operations, and where the input corresponds to a natural speech error.

Given this repair (or "recycling") theory of ellipsis, an obvious question is whether split-antecedent ellipsis, see (3) below, is a case of repair. We will argue that it is not. Instead it shows the hallmarks of accommodation (see discussion below immediately preceding

Section 3.1), and none of the usual characteristics of repair. This leads to the question of the circumstances under which mismatch ellipsis is repaired and the circumstances under which an antecedent can be felicitously accommodated. Below we present preliminary evidence for the following hypothesis.

> Activated Syntactic Memory (ASM) hypothesis: Memory holds the syntactic representation of the current sentence and the last potentially independent clause (assuming clauses of average size and complexity). An antecedent is repaired if it is within ASM. If an antecedent is not within ASM, a detailed syntactic structure of the antecedent may not be available to repair.

The structure of the paper is as follows. We give a synopsis of the evidence supporting the repair/recycling account in Section 2. Section 3 takes up split-antecedent ellipsis, arguing that it is not a case of repairing the antecedent to a grammatical/matching antecedent. Section 4 investigates the effect of having distant antecedents on the processing of pronouns and ellipsis, and presents preliminary evidence that split antecedents cannot be repaired because at least one of the conjuncts is too far away. Section 5 looks more carefully at the ASM hypothesis, explores its predictions about the circumstances of repair vs accommodation, and presents an initial test of one of its predictions. Section 6 concludes.

2 The Recycling account

The recycling account of mismatch ellipsis is based on the idea that the processor searches for a grammatical analysis of an input. Lacking a fully grammatical analysis, it may make certain repairs, especially if the input corresponds to a likely speech error, e.g., syntactic blend of an antecedent clause with one voice and an ellipsis clause in a different voice. The processor in general seems able to reverse natural speech errors (Frazier & Clifton 2011a; 2015). Making a slight repair to an input structure may be considered a type of cooperative comprehension. Interestingly, ellipsis repairs share features of garden path repairs, in that repairs are done when only few operations are needed and there is lots of evidence for them (e.g., Frazier & Clifton 1998). In both garden path repair and input repair, semantic plausibility matters, with repair being easier if the first interpretation is implausible and the final interpretation is plausible. Neither in the case of garden path repair nor in the case of ellipsis repair is it possible at present to say precisely how many repair operations can be accomplished successfully. This is at least in part because the ability to revise or repair depends on the amount of evidence indicating the need for a repair and the informativeness of the repair signal (and possibly even on the motivation of the comprehender).

  In studies of mismatch ellipsis, the acceptability decrement observed for a mismatching antecedent is related to the number of additional or repair steps required in comprehension (Arregui et al. 2006). Acceptability drops from an available matching VP antecedent (1a), to a matching VP embedded inside a determiner phrase (DP) in a non-canonical position for a VP (1b), to replacing the empty object of *see* in (1c) with its ultimate binder (1c), with the worst (we assume) unacceptable ungrammatical case in (1d), where an appropriate antecedent would need to be built from scratch after ripping *see* out of the adjective in (1d).

(1)   a.   None of the astronomers saw the comet, /but John did.   (Available verb phrase)

        b.   Seeing the comet was nearly impossible, /but John did. (Embedded verb phrase)

        c.   The comet was nearly impossible to see, /but John did. (Verb phrase with trace)

        d.   The comet was nearly unseeable, /but John did.   (Negative adjective)

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Table 1: Percentage acceptable responses and reaction time (ms), Experiment 1. "/" marks the division of each sentence into two portions, which participants moved through by button-press.

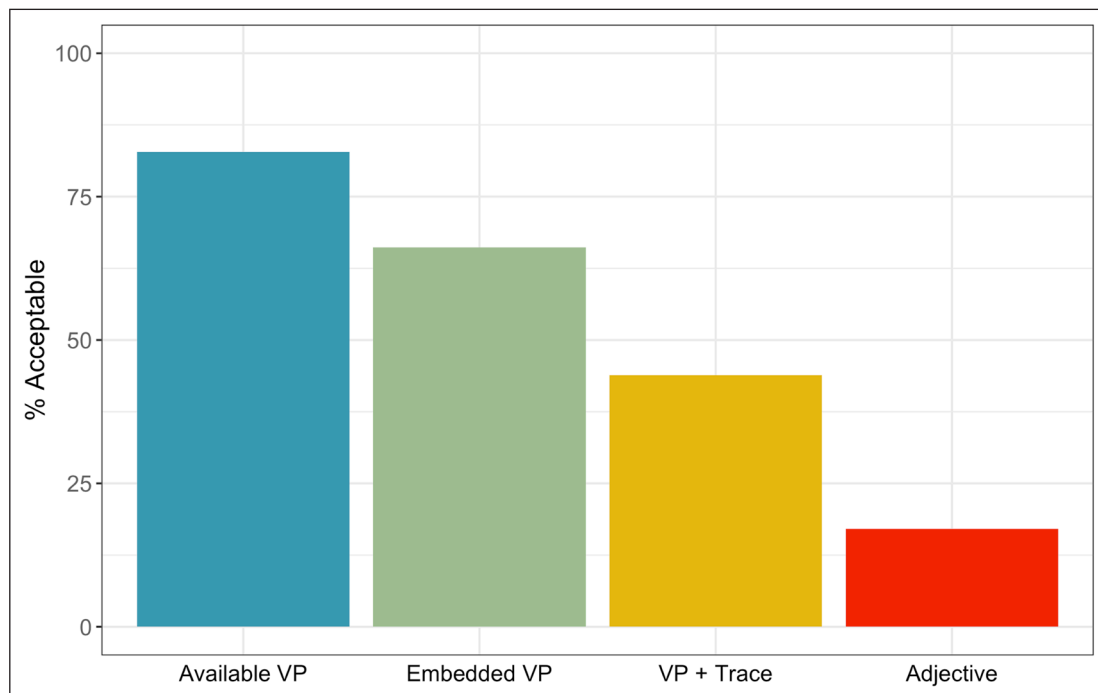|		% Acceptable	Reaction Time
a.	Available verb phrase	82.8	2146
b.	Embedded verb phrase	66.1	2230
c.	Verb phrase with trace	43.9	2399
d.	Negative adjective	17.1	2298

Figure 1: Percentage acceptable responses from Arregui et al. (2006) Expt. 1.

These results, provided in Table 1 and Figure 1, and others presented in the Arregui et al. paper, for example showing that verbal gerundive antecedents are more acceptable than nominal gerundive antecedents for VP ellipsis, suggest the processor repairs antecedents and the result is relatively acceptable under particular circumstances.[1]

Garnham & Oakhill (1987) presented readers with mini-discourses like (2) containing VP ellipsis that would result in either a plausible or implausible interpretation. The answer to questions about the final sentence indicated that only with *the nurse* as subject of the final sentence did participants report any non-matching interpretations where the final clause is interpreted as having active rather than passive voice.

(2)   It had been a busy morning in the hospital. The elderly patient had been examined by the doctor. The child/nurse had too.

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[1] In the grammar and in language production, it is relatively straightforward to check whether there is matching between antecedent and elided constituent. In comprehension, however, one might be concerned that the silent structure at the ellipsis site can only be determined by the structure of the antecedent, raising questions about how matching could be enforced. We assume that a sentence like *Alice did.* contains sufficient information to determine the need for an active-voice VP that takes auxiliary *do*; more detailed structure is presumably dependent on the structure internal to the antecedent.

The results, in our view, suggest repair to a plausible interpretation (the nurse examined the patient) is possible, but not to an implausible one (the child examined the patient).[2]

Acceptability of an ungrammatical form in general and in the case of ellipsis in particular depends on its ease of repair (number of operations needed, amount of evidence for them), the plausibility of the ultimate form (the token based parsing system only delivers plausible meanings, Frazier 2015), and the likelihood or naturalness of the input as a speech error (see Coppock 2006). Relevant evidence derives from the existence of a voice mismatch asymmetry predicted by the human tendency to misremember a passive as an active more often than the other way around (Mehler 1963; Arregui et al. 2006; Clifton et al. 2019; but also Merchant 2008). The idea that speakers/hearers may forget the form of an antecedent clause predicts that the acceptability of mismatches will be higher when common syntactic alternatives are available for encoding a message (e.g., as a coordinate VP vs S, Frazier & Clifton 2011b). Other studies indicate that the acceptability of mismatches is lower when attention is directed to the form of the input, and higher when the imperfect form comments on the question under discussion (QUD) (Grant et al. 2012). Given this evidence for repair of mismatch ellipsis, we now ask whether processing split antecedent ellipsis involves repair.

3 Split antecedents

The marquee example of split antecedent VP ellipsis is in (3), due to Bonnie Webber (1978).

(3)   Webber (1978)
       Bob wants to sail round the world and Alice wants to climb Kilimanjaro, but
       neither of them can [ ], because money is too tight.

Split antecedent ellipsis is a label for a particular kind of mismatch ellipsis that can be relatively acceptable despite the fact that there is no surface matching antecedent for the elided VP. There are many theories of split antecedent ellipsis. Starting with Hardt (1999) there has been the idea that a null pro-form is present after the auxiliary, rather than an elided constituent, and that there has to be an accessible antecedent recoverable in the discourse context (see Dalrymple et al. 1991; Miller & Hemforth 2014 on polar noun antecedents for VP ellipsis; Miller & Pullum 2014 for discussion of exophoric examples; and Poppels & Kehler in this volume for an anaphoric account based on discourse anaphora). Elbourne (2008) presents an approach based on constructing a maximal plural predicate. A context variable restrictor R then supplies the constraint on how the plural predicate is mapped to referents, e.g., with a "respectively" relation.[3]

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[2] In general reanalysis of a structure implicates not only syntactic but also semantic and pragmatic information (Pickering and Traxler 2000, Frazier and Clifton 1998). Thus, the fact that plausibility can influence repairs is not surprising or exceptional.

[3] Messick, Saab & Vicente (2016) place R not in the fragment but in the ellipsis site. This accounts for the obligatoriness of a restrictor in the Barros effect, i.e., the obligatory restrictor in (ib) and the obligatory inheritance of the restrictor (students) in (iib).

(i)   Jack kissed Sally, and he also kissed someone else.
       a.   #but I don't know who he kissed.
       b.   but I don't know who.
(ii)   A: Which students were dancing in the quad?
       a.   B: Some Germans were dancing in the quad. (don't have to be students)
       b.   B': Some Germans. (must be students)

A similar account is offered for split antecedent sluicing in cases like (6).

(iii) Whenever Jack wants to interview an athlete or Sally wants to profile a politician,
       the editor asks which.

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What would a repair theory of split antecedents look like? The processor could use conjunct 1 and conjunct 2 to build a VP (cf. Fiengo & May 1992; 1994 on syntactic reconstruction), as sketched in (4). The distributivity of the subject might determine whether the VPs are conjoined or disjoined.

(4)   a.   Bob wants to [$_{VP1}$ sail round the world] and Alice wants to [$_{VP2}$ climb Kilimanjaro], but neither of them can [ ], because money is too tight.
but neither of them can: "VP1 or VP2"

        b.   Bob doesn't want to [$_{VP1}$ sail round the world] and Alice doesn't want to [$_{VP2}$ climb Kilimanjaro], but they will [ ], because they made a promise to each other.
but they will: "VP1 and VP2"
and they each can "VP1 or VP2 respectively"

The central repair would thus be building a single VP from the VPs in two source clauses. So the question is whether indeed it is a repair that produces the antecedent needed for split antecedent ellipsis.

We will approach this question by asking whether the operations used in processing split antecedents look like other syntactic repair operations that change the form of the input, e.g., is an example requiring repair less acceptable than one not needing repair, are simpler repairs preferred? In the case of processing garden path sentences revisions of structure are needed, e.g., after incorporating *the old torn sock* as the object of *mend* in *While Mary was mending the old torn sock fell off her lap.*, the postverbal DP must be reanalyzed as the subject of *fell off*. Having more evidence for the repair facilitates processing (e.g., Pickering & Traxler 2000; Fodor & Ferreira 1998). Revisions with more operations are known to be difficult especially when there is not clear evidence indicating which operations are needed (e.g., *The horse raced past the barn fell.*).

In contrast to repair, the operations involved in split antecedent ellipsis might instead involve some form of accommodation, i.e., semantically adjusting the common ground (CG) to make the discourse coherent or to satisfy presuppositions (Stalnaker 2002), justify the epistemic state of the speaker, or the like.

Repair and accommodation are expected to have different properties, flowing from a core difference in targets. Repairs have syntactic structure as their targets, whereas accommodation is a matter of propositions. Consequently, the distance between the input and the adjusted representation differs depending on whether repair or accommodation is involved: for repair, the distance metric depends on the number and cost of operations defined on a syntactic structure, but for accommodation, the relevant distance might be a function of the differences between a proposition and the existing common ground. We also expect that the initiation of a repair should be the result of an accumulated amount of evidence to its necessity, while accommodation can be dependent on, e.g., a particular presupposition trigger. Further, repair comes with a measurable processing and acceptability cost, whereas accommodation can be easier or more acceptable than a counterpart not requiring accommodation (compare: *Josh's wife is sick.* vs *Josh has a wife. She is sick.*).

Below we present three experiments designed to arbitrate between these accommodation and repair theories of split antecedent ellipsis.[4]

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[4] The experiments in this section were conducted with the generous assistance of Chuck Clifton.

3.1 Experiment 1: Paraphrase elicitation

We conducted a pilot experiment investigating the paraphrases proposed by participants for elliptical clauses like *but neither of them can* in (3). This showed that the most common paraphrase of (3) was "but neither of them can [do what they want]" though a range of paraphrases were given. This does not fit neatly with a repair theory of split antecedents since we would **expect a minimal repair of the surface form, using the copied VPs**. In other words, if a VP has just been formed by conjoining two VPs we might expect participants to provide something like this form as a paraphrase. The pilot results motivated a larger-scale investigation to determine whether paraphrases of split antecedent ellipsis stay close to the structure of a repaired antecedent, which we report below.

3.1.1 Method and materials

We recruited 25 adult native speakers of English on Amazon's MechanicalTurk platform. Each participant was presented with a form containing four questions consisting of a tri-clausal sentence and a completion prompt soliciting a paraphrase for the final clause. Two sample questions are demonstrated in (5) and (6). The tri-clausal sentences were each composed of two parallel coordinates and a corresponding split antecedent ellipsis site.

(5)   Wendy is eager to sail around the world and Bruce is eager to climb Mt. Kilimanjaro, but neither of them has so far.
Please say what you took that to mean by completing this sentence:
"So far, neither of them ….."

(6)   Katherine plans to work in her hometown in January and Sam plans to help his parents, and both of them will without complaint.
Please say what you took that to mean by completing this sentence:
"Without complaint both of them ….."

Participants responded by typing their continuations into a provided text box beside each item. Upon completion of the four prompts, participants were paid $0.50 for their participation.

3.1.2 Results and discussion

Responses were coded as one of three templates: a superordinate category paraphrase, a conjoined VP paraphrase referencing both preceding conjuncts, and a single VP paraphrase referencing only one of the preceding conjuncts.

Representative completions are given in (7), along with counts.[5] 69% of the time, participants gave a superordinate category completion (7a) as opposed to interpretations which contained material copied from the surface inputs (7b–c).

(7)   Illustrative completions:
a.   … has gone on their anticipated adventures.
(69/100 responses-single superordinate VP)

b.   … has accomplished their dream of either sailing around the world or climbing Mt. Kilimanjaro. (19/100 coordinate VP)

c.   … have been to Mt. Kilimanjaro. (11/100 single VP)

In accordance with early pilot data, the results of the completion study indicated a range of interpretations for cases of split antecedent ellipsis, with a majority of them corre-

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[5] 99 of the 100 responses were coded. The remaining response, "*needs to take care of family.*", given for prompt (9), was deemed unclassifiable.

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sponding to something other than minimal repairs of the surface input (e.g., disjoined copied VPs). This is unexpected on the repair account for split antecedent ellipsis, in that we find a majority of cases with no evidence of structural relationship with the original conjuncts.

3.2 Experiment 2: Parallelism of VPs and naturalness

One central prediction of a repair account is that we expect a larger effect of parallelism with ellipsis than without. On the repair account, in ellipsis sentences, conjuncts which are parallel would allow for easier and more confident construction of the appropriate VP antecedent than would non-parallel cases. We manipulated parallelism by varying the choice between deontic vs bouletic modals (Carlson 2002) in the introductory sentences of split antecedent examples like (3) above, using parallel (e.g. be eager to/be eager to; want to/be eager to) or non-parallel (be eager to/be supposed to) modal expressions. The parallel modality in the two conjuncts may serve as a type of evidence supporting the construction of the single target VP needed in order to satisfy the matching constraint. In cases without ellipsis, whatever interpretive benefit parallel modality provides is expected to be weaker since no repair is needed. We tested these predictions in a written naturalness rating study.

3.2.1 Method and materials

52 undergraduate students at UMass Amherst, participating for course credit, were asked to rate sentences on a scale from 1–7 according to their naturalness, where a 1 is judged to be totally unnatural, and a 7 as perfectly natural. After five practice items intended to familiarize participants with the task and response scale, including feedback which encouraged sensitivity to discourse influences, each participant saw 16 items like those in (8) which, as above, contained two conjoined antecedent clauses followed by a third clause. Antecedents either exhibited parallelism (+Par) (8a, c: *eager-eager*) or not (–Par) (8b, d: *eager-supposed to*) and the final clause either exhibited ellipsis (+Ell) (8a, b: *neither of them has*) or contained the VP anaphor *do it* (–Ell) (8c, d: *neither of them has done it*).

(8)   a.   Wendy is eager to sail around the world and Bruce is eager to climb Mt. Kilimanjaro, but neither of them has so far.   (+Ell, +Par)

      b.   Wendy is eager to sail around the world and Bruce is supposed to read a book about Mt. Kilimanjaro, but neither of them has so far.   (+Ell, –Par)

      c.   Wendy is eager to sail around the world and Bruce is eager to climb Mt. Kilimanjaro, but neither of them has done it so far.   (–Ell, +Par)

      d.   Wendy is eager to sail around the world and Bruce is supposed to read a book about Mt. Kilimanjaro, but neither of them has done it so far.   (–Ell, –Par)

Participants were presented with the 16 target items alongside 76 filler items, including other acceptability ratings and forced-choice interpretation questions about both simple passages and short hypothetical dialogues. For this study and all subsequent studies reported here in which items were presented in multiple conditions, participants were shown Latin squared sub-lists, such that every participant saw each item only once, in one condition.

3.2.2 Results

The mean naturalness ratings are presented with standard errors in Table 2 and Figure 2.

Table 2: Mean naturalness ratings (1–7) (with standard errors).

	+Ellipsis	*−Ellipsis*	*Mean*
+Parallel	**4.99 (0.10)**	**5.18 (0.10)**	5.09
−Parallel	**4.32 (0.11)**	**4.41 (0.11)**	4.36
Mean	4.66	4.80	
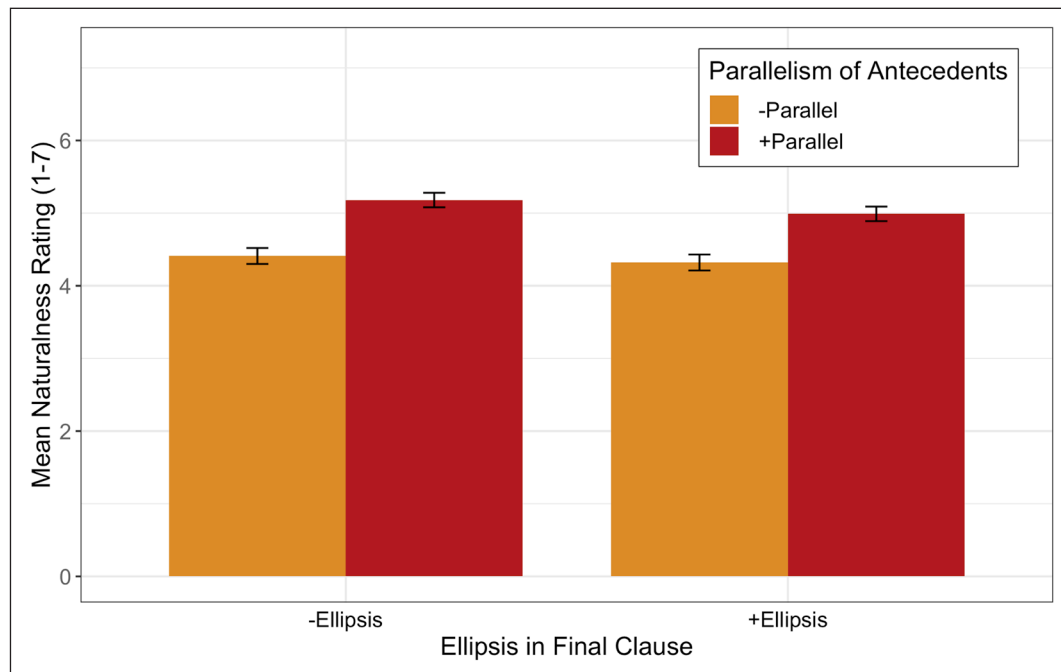
Figure 2: Mean naturalness ratings (1–7) (with standard errors) from Experiment 2.

Parallel examples were rated higher than non-parallel ones ($b = -0.55$, $z = -5.62$, $p < .001$).[6] There was no significant effect of ellipsis ($b = -0.13$, $z = -1.45$, $p = .148$), and critically **no interaction of ellipsis × parallelism** ($b = 0.05$, $z = 0.70$, $p = .484$).

3.2.3 Discussion

We see no evidence of a particular parallelism benefit for split antecedent ellipsis in naturalness ratings. The data thus again fail to support the predictions of the repair account.

In standard cases of VP ellipsis, there are stronger acceptability effects of parallelism with VP ellipsis than with *did it* anaphora (Tanenhaus & Carlson 1990; Miller & Hemforth 2014 among others). Of course, in those cases, it is the parallelism of the antecedent and the ellipsis site that is manipulated. In the present case, the parallelism of the conjuncts was manipulated on the assumption that building a single VP would be facilitated by highly parallel conjuncts (X wants…and Y wants…) compared to less parallel ones (X wants… and Y is supposed to…).

By contrast with the processing of standard VP ellipsis, processing presuppositions does not seem to give rise to strong parallelism effects. For example, Göbel (2017) and Göbel et al. (2018) investigates the processing of the additive presupposition trigger *too* to determine whether a discourse is more acceptable when the antecedent of *too* is parallel in

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[6] All naturalness judgement data are analyzed with ordinal mixed-effects regression, with Participant and Item as random predictors, using the *ordinal* package in *R*. We report the estimated slope, z score, and p-value for all predictors of interest. Regressions were performed in *R* (R Core Developers 2018) using the *ordinal* package (Christensen 2018).

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form to the sentence containing *too* than when it is not parallel. Specifically, as illustrated in (9), the initial (presupposition satisfying) sentence of a three sentence discourse could be (a) syntactically and lexically parallel to the final sentence, which contained *too,* (b) syntactically non-parallel (in voice) to the final sentence; or (c) semantically equivalent where the initial sentence is syntactically parallel to the final sentence but lexically non-parallel, containing a quasi-synonymous verb. Göbel tested items like (9) in a written acceptability judgment task (Table 3). He finds no effect of structure (parallel, syntactically non-parallel, semantic equivalence), but significantly higher acceptability ratings when the final sentence contained *too* than when it did not. Crucially there was no interaction of structure and the presence/absence of *too*.

(9)   a.   At dinner, the butler disobeyed the countess.   (Parallel)
        b.   At dinner, the countess was disobeyed by the butler.   (Synt. Non-Parallel)
        c.   At dinner, the butler defied the countess.   (Sem. Equivalent)
        The other staff were worried about bad consequences for him.
        Surprisingly, he disobeyed the count (**too**).

Although processing presuppositions in discourses satisfying those presuppositions need not travel hand-in-hand with accommodating presuppositions in cases of presupposition violation, the results of Göbel's study do suggest that not all operations on sentence-level interpretations show concomitant effects of syntactic structure or structural parallelism. In principle, one could imagine that accessing meaning for whatever purpose implies facilitation for syntactic parallelism. But that is not what he finds.

In sum, in Göbel's study processing a presupposition is not influenced by the structure or parallelism of the sentence satisfying the presupposition and the sentence containing the presupposition trigger. This indifference to structure and parallelism is in sharp contrast to what is found for sentences with ellipsis (Tanenhaus and Carlson 1990; Kim and Runner 2018; among others).

3.3 Experiment 3: Facilitation from multiple accommodations

As shown intuitively by the acceptability of (10b) below, the source material for an elided VP can come from two or more different sentences.

(10)   a.   Josh always wanted to go to Harvard. Lulu always wanted to go to Yale.
        Despite hard times, they can go to Harvard and go to Yale.
        b.   Josh always wanted to go to Harvard. Lulu always wanted to go to Yale.
        Despite hard times, they can [   ].

This is quite unlike other cases attributed to repairing or revising an analysis. We will use such multiple-sentence instantiations of split antecedent ellipsis in our third study as a check on our intuition that (10b) is unproblematic.

Table 3: Mean acceptability judgments (1–7) from Göbel (2017).

	with too	without too	(differences)
Parallel	**5.04**	**3.25**	−1.79
Semantic Equivalence	**4.93**	**3.45**	−1.48
Syntactic Non-Parallel	**4.91**	**3.26**	−1.65

If the antecedent for split antecedent ellipsis is accommodated rather than repaired, then we might expect facilitation from the presence of (or need for) another accommodation in the same clause. The intuition behind this expectation is that making use of or reference to the source clause for ellipsis for purposes of another accommodation activates relevant representations of that clause (including at least the corresponding proposition) and serves as a clear indicator that the speaker is taking the material in that clause to be available to the comprehender. To explore this possibility, the experimental items contained an accommodated subject in the ellipsis clause in the form of a subject pronoun. On the other hand, if VPs are repaired, then there is no reason to expect an interaction of ellipsis and the form of the subject. Note that a main effect of preferring a pronoun subject might be found due simply to the "Repeated name penalty". Thus, it is a reliably larger preference for a pronoun in clauses with ellipsis than in clauses without ellipsis that is critical, not just a main effect of pronominal subjects. We tested this in another naturalness rating study.

3.3.1 Method and materials

We recruited 38 adult native speakers of English on Mechanical Turk. After three training items, participants provided naturalness ratings (1–7) to 16 three-sentence passages like (11). Sentences one and two of these passages were analogous to the conjoined antecedents in experiments above. The final sentence was manipulated to contain coordinated names (–Pro) (11a, b: *Josh and Lulu*) or a pronominal subject (+Pro) (11c, d: *they*), and either exhibited ellipsis (+Ell) (11b, d: *can*) or not (–Ell) (11a, c: *can go to Harvard and go to Yale*).

(11)   a.   Josh always wanted to go to Harvard. Lulu always wanted
             to go to Yale. Despite hard times, Josh and Lulu can go to
             Harvard and go to Yale.   (–Pro, –Ell)
       b.   Josh always wanted to go to Harvard. Lulu always wanted to
             go to Yale. Despite hard times, Josh and Lulu can.   (–Pro, +Ell)
       c.   Josh always wanted to go to Harvard. Lulu always wanted to
             go to Yale. Despite hard times, they can go to Harvard and go
             to Yale.   (+Pro, –Ell)
       d.   Josh always wanted to go to Harvard. Lulu always wanted to
             go to Yale. Despite hard times, they can.   (+Pro, +Ell)

Participants also saw seven filler items spanning the range of naturalness. We removed from our sample three subjects who reliably responded too fast to be adequately reading the stimuli, leaving a sample of 35. All 38 participants were compensated $1.00 for about 8 minutes of work.

3.3.2 Results

The mean naturalness ratings are presented in Table 4 and Figure 3.

In addition to a main effect of subject type such that pronominal subjects exhibited a naturalness advantage ($b = 0.79, z = 4.35, p < .001$), we find a significant interaction of subject type × ellipsis ($b = 1.15, z = 3.45, p < .001$), with elliptical examples showing a

Table 4: Mean naturalness ratings (1–7) (with standard errors).

	–Pronoun	*+Pronoun*
–Ellipsis	4.62 (0.13)	4.77 (0.13)
+Ellipsis	4.21 (0.13)	5.04 (0.13)

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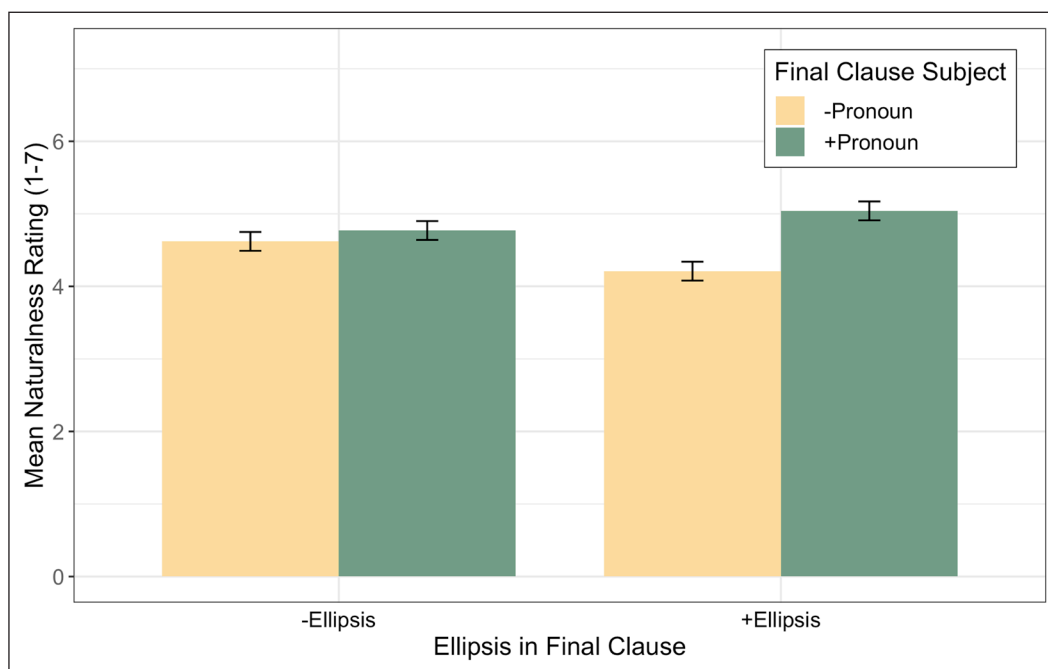
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Figure 3: Mean naturalness ratings (1–7) (with standard errors) from Experiment 3.

greater pronoun advantage (Pronoun – Coordinate = 0.83) compared to the non-elliptical examples (Pronoun – Coordinate = 0.15).

This is as expected on an accommodation approach to split antecedents, but not on a repair account.

3.4 *General Discussion*

To summarize, the processing of split antecedent ellipsis does not exhibit the same properties as syntactic repair, e.g., repair in garden path sentences (Fodor & Ferreira 1998; Frazier & Clifton 1998), and repair in the processing of mismatch ellipsis (Arregui et al. 2006; Frazier & Clifton 2005). We have shown here that:

1. paraphrases vary but need not stay close to the structure of the input
2. the source material for the repair can come from two distinct independent sentences
3. parallel examples are better than non-parallel but there appears to be no interaction with ellipsis
4. "*they* + VPE" with split antecedent is more acceptable than "DP *and* DP + VPE" with split antecedent (attributed to having another accommodation in the ellipsis clause)

We conclude that split-antecedent ellipsis is not a matter of repair, and conjecture that it is due instead to accommodation.

But this leaves us with a puzzle: Examples of acceptable mismatches sometimes involve repair, sometimes not. For the repair theory to be explanatory, it is essential to be able to predict the circumstances under which repair takes place. It is to this puzzle that we now turn.

4 Distance effects and ASM

Following Frazier & Clifton (2005), we will assume that syntactic representations are couched in the vocabulary of DP, VP, c-command, etc.; salience relations in the syntactic representation are based on recency. Discourse representations are couched in the

vocabulary of information structure (topic…) and show distinct salience relations based on focus, main assertion and the like. Given our assumption that the grammar requires a syntactically matching antecedent for elided constituents, it is then predicted that a larger distance effect should obtain for ellipsis than for discourse anaphora, which requires only a referent in the discourse representation. Although surely an idealization, we further suggest that it is the current clause/sentence and the last potentially independent clause that tend to be active in ASM as a discourse is processed.

Below we report three studies that test this prediction. The distance facts are of some interest in their own right. But in the present paper they will also serve to underpin assumptions about what syntactic material is readily accessible in ASM. This will be critical for our explanation of when the processor makes repairs of mismatch ellipsis and when it accommodates an antecedent.

We begin with the results of a small pilot study in which 12 local participants provided naturalness ratings (1–7) for 8 sentences like those in (12). The question is whether the distance effect (±Distant) for ellipsis (Ell), the (c)–(d) difference, is larger than it is for pronouns (Pro), i.e., the (a)–(b) difference.[7]

(12) a. Carl will go to college now that Sally dropped out, according to their friends.
          She was going to Brooklyn Tech.   (Pro, + Distant)

      b. Carl will go to college now that Sally dropped out.
          She was going to Brooklyn Tech.   (Pro, –Distant)

      c. Carl will go to college now that Sally dropped out, according to their friends.
          Joanna did too.   (Ell, + Distant)

      d. Carl will go to college now that Sally dropped out.
          Joanna did too.   (Ell, –Distant)

The means are presented in Table 5 and Figure 4. Though no statistical analysis was performed, the difference between the distant and the nearby antecedent conditions was twice as large for ellipsis examples compared to the pronoun examples.

Below we will present full scale studies that will reinforce this conclusion. The comparison is of interest, we think, because the pronominal DP and the VP ellipsis do not compete with each other as ways to express the same message. In comparisons of VP ellipsis and "do + pronoun" anaphora, one has superficially closer forms (*did* vs *did it* vs *did so*) but the results might reflect in part the **non**-choice of the competing form (see Miller 2011 for corpus studies capturing some of the environments in which the various forms tend to be used).

4.1 Experiment 4: Distance and antecedent choice in ellipsis and discourse anaphora

Returning to the question of what material is readily accessible in ASM, we performed an interpretation experiment testing the accessibility of antecedents in main clauses as compared to subordinate clauses. As main clauses, we use conjoined clauses introduced by the

Table 5: Mean naturalness ratings (1–7) in a small pilot study.

	–Distant	+Distant	Difference
Pronoun	4.66	4.29	0.37
Ellipsis	3.00	2.37	0.63

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[7] A reviewer was concerned that the ellipsis examples are ambiguous whereas the pronoun is disambiguated by gender. This could limit the conclusions that could be drawn. However, in Experiment 5 there is only one possible antecedent for the verb phrase ellipsis and, again, significantly larger distance effects are found for ellipsis compared to pronouns.
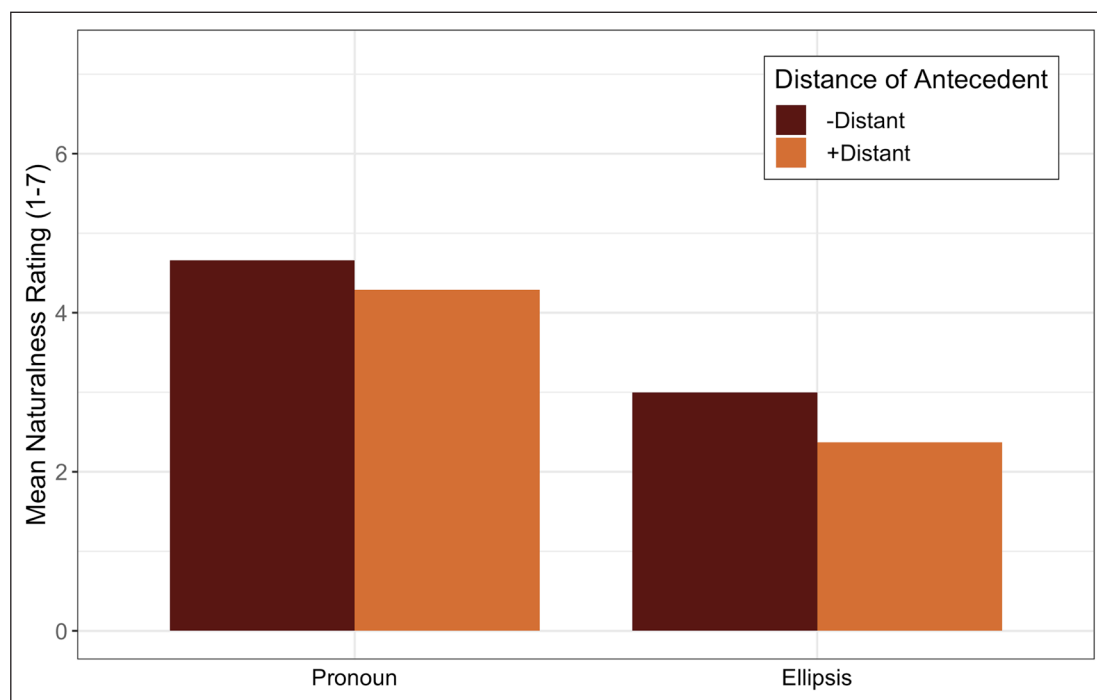
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Figure 4: Mean naturalness ratings (1–7) in a small pilot study.

connective *but*, compared to subordinate conjoined clauses introduced by the connective *after*. We assume clauses conjoined with *and* or *but* function as independent sentences (they are V2 in languages like German) and are distinct from subordinate clauses.

As mentioned above, pronouns and ellipsis are distinct types of dependencies, taking antecedents in distinct representations (discourse representation vs syntactic representation respectively). However, they may both be influenced by effects of connective type and their impact on the status of the clause: with a coordinating conjunction like *but* the clause is salient in the discourse representation and acts like a main clause in the syntax; whereas with a subordinating conjunction like *though*, it is presumably backgrounded in the discourse and syntactically subordinate. More specifically, we assume that resources are devoted to keeping the syntactic representation of the main clause available in ASM, and thus it is accessible for longer than the syntactic representation of a subordinate clause. The prediction of our general assumptions about syntactic vs discourse representation is that ellipsis — and syntactic representation in general (Frazier & Clifton 2005) — shows larger recency effects (salience in syntax) than pronouns do. Further, examples containing *but* should show more recent antecedents than examples containing *after*.[8]

4.1.1 Method and materials

Examples like those in (13) were tested in a forced choice interpretation study. 40 MechanicalTurk users, all adult native speakers of English, indicated whether the pronoun/elided constituent in the final sentence was interpreted using the first (Carl/went to college) or later (Bill/dropped out) antecedent. The first sentence of a two sentence discourse contained a main clause and either an *after*-clause (+Dep) (13a, c) or a *but*-clause (–Dep) (13b, d). In addition, a subordinate *though*-clause appeared either at the end (+Distant) (13a–d) or at the beginning (–Distant) (13e–h) of the first sentence. The second sentence contained either a pronoun (Pro) (13a, b, e, f) or an elided VP (Ell) (13c, d, g, h). The

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[8] Note this follows either on the assumption that the last potentially independent clause is accessible in ASM, or from the main assertion hypothesis, cf. Frazier and Clifton (2005). These are not mutually exclusive hypotheses and we will not attempt to tease them apart here.

boldface in (13) is used for expositional purposes and did not occur in the actual experiment; it indicates the last potentially independent clause when the final sentence of the discourse is being processed.

(13)   a.   **Carl went to college** after Bill dropped out though economic times were tough.
            He was scared.   (+Distant, Pro, +Dep)

       b.   Carl went to college **but Bill dropped out** though economic times were tough.
            He was scared.   (+Distant, Pro, –Dep)

       c.   **Carl went to college** after Bill dropped out though economic times were tough.
            Sally did too.   (+Distant, Ell, +Dep)

       d.   Carl went to college **but Bill dropped out** though economic times were tough.
            Sally did too.   (+Distant, Ell, –Dep)

       e.   Though economic times were tough, **Carl went to college** after Bill dropped out.
            He was scared.   (–Distant, Pro, +Dep)

       f.   Though economic times were tough, Carl went to college **but Bill dropped out.**
            He was scared.   (–Distant, Pro, –Dep)

       g.   Though economic times were tough, **Carl went to college** after Bill dropped out.
            Sally did too.   (–Distant, Ell, +Dep)

       h.   Though economic times were tough, Carl went to college **but Bill dropped out.**
            Sally did too.   (–Distant, Ell, –Dep)

Pronoun and ellipsis cases were completed separately in two blocks of 20 items each, with block order balanced across participants. This block structure was adopted to control for any influence that exposure to the task of resolving pronominal ambiguity might have on resolving elliptical ambiguity, and vice versa. Each block also contained 24 filler items questioning pronoun and ellipsis resolutions with similar ambiguities and a variety of biases to the first or second antecedent. As throughout this study, each participant saw a Latin squared sub-list containing each item only once. On completion, participants were paid $2.00 for about 16 minutes of work.

The hypothesis that ellipsis takes a syntactic antecedent whereas discourse anaphora implicates a referent in the discourse representation predicts that distance effects will be larger for ellipsis than for anaphora, as in the pilot study just reported. Here that should surface as fewer "initial clause" (Carl went to college) antecedents for ellipsis than for anaphora especially in the distant condition, where the *though*-clause appears between the first and second sentences. Given that we expect *but* to instantiate a new potentially-independent clause, we further predict fewer "main clause" (Carl went to college) responses in *but* sentences than in *after* sentences, an effect that should be larger for ellipsis (where a syntactic antecedent is implicated) than for the pronoun, perhaps especially for the distant condition, where the *though*-clause intervenes between the first and second sentences. Put differently, there should be a stronger tendency to adopt an antecedent from the boldfaced clause in (13) for ellipsis than for anaphora.

4.1.2 Results and discussion

The results are presented in Table 6 and Figure 5 in terms of the percentage of "initial clause" (Carl went to college) interpretations. As expected, both ellipsis ($b = –0.31$, $z = –2.23$, $p = .025$)[9] and independence of the second clause (*but*) ($b = –1.23$, $z = –9.45$,

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[9] We analyze all forced-choice data with logistic mixed-effects regression, with Participant and Item as random predictors, using the *lme4* package (Bates et al. 2015) in *R*. We report the estimated slope, Wald Z score, and p-value for all predictors of interest.

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Table 6: Percentage "initial" clause (Carl went to college) antecedents (with standard errors).

Pronouns	+Dep (after)	−Dep (but)
−Distant	**78.0** (2.9)	**42.0** (3.5)
+Distant	**82.5** (2.7)	**48.0** (3.5)
Ellipsis	**+Dep (after)**	**−Dep (but)**
−Distant	**79.5** (2.9)	**22.0** (2.9)
+Distant	**68.5** (3.2)	**37.5** (3.4)
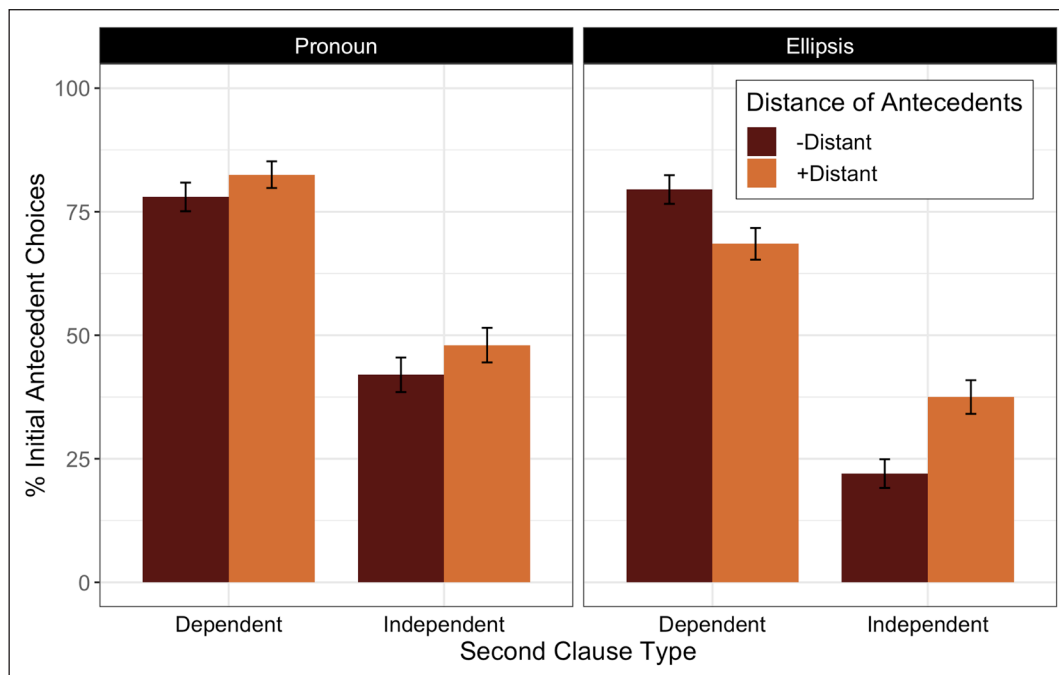
Figure 5: Percentage "initial" clause antecedents (with standard errors) from Experiment 4.

$p < .001$) decreased initial antecedent responses. There was an interaction of distance and second clause independence ($b = 0.26$, $z = 3.56$, $p < .001$): intervening material resulted in a larger effect (increase in initial antecedent responses) when the second clause was independent (*but*) than when it was dependent (*after*). There was also a three-way interaction of pronoun/ellipsis × second clause independence × distance ($b = 0.25$, $z = 0.07$, $p < .001$). The intervening material decreases initial clause antecedents (favors recent antecedents) more for ellipsis than pronouns, especially when the second antecedent is in an independent clause.

The results suggest that pronoun antecedent resolution is less influenced by distance and by the dependence (as manipulated by *but, after*) of a recent clause than ellipsis antecedent resolution. Consistent with the idea that ellipsis requires a syntactic antecedent, it is affected more by distance (whether the though-clause appears initially or finally) than is the pronoun, and more by the dependence of a recent clause than is the pronoun.[10,11]

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[10] A reviewer asked whether the larger effect of distance for *but* than for *after* was predicted. Our account claims that the *but* clause VP is a more attractive antecedent than the *after* clause VP and thus it is not particularly surprising that distance had a large effect on the former. Philip Miller (pers. comm.) points out that the discourse conditions he proposes (that asserting a clause p makes the alternative not-p salient and thus makes it a preferred antecedent for ellipsis) might account for this result.

[11] It is possible that distinct coherence relations were assigned to but-clauses and *after*-clauses. In principle, this might account for why the connective had an effect for pronouns as well as for ellipsis, though many additional factors may also be relevant.

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4.2 Experiment 5: Distance and the naturalness of ellipsis and discourse anaphora

The next experiment again examines distance effects for pronouns vs ellipsis. In order to maximize the naturalness of the sentences and limit the number of conditions, it did not manipulate the connective (the *but/after*-clause of the previous experiment was omitted).

4.2.1 Method and materials

66 participants on MechanicalTurk were asked to rate 16 written mini-discourses on a naturalness scale from 1 to 7 after reading the sentences in a self-paced fashion. The slashes in (14) indicate presentation regions. As in the last experiment, the second sentence contained either a pronoun (Pro) (14a, b) or an elided VP (Ell) (14c, d). This factor was crossed with the presence (+Distant) (14b, d) or absence (–Distant) (14a, c) of an intervening *though*-clause.

(14)   a.   Carl went to college. | He was scared.   (Pro, –Distant)

        b.   Carl went to college, | though economic times were tough. | He was scared.

                                                                      (Pro, +Distant)

        c.   Carl went to college. | Joanna did too.   (Ell, –Distant)

        d.   Carl went to college, | though economic times were tough. | Joanna did too.

                                                                        (Ell, +Distant)

            How natural was this passage?

10 participants were removed for mean ratings of more than 3.5 on attention check questions written to be ungrammatical, leaving a sample of $n = 56$. All participants were compensated with $1.00 for about 8 minutes of work.

4.2.2 Results and discussion

The mean naturalness ratings are presented in Table 7 and Figure 6.

    There was a significant effect of distance ($b = –1.04, z = –9.69, p < .001$), and an interaction with a larger penalty for non-local antecedents with ellipsis than with pronouns ($b = –0.30, z = –3.65, p < .001$). This interaction was expected and is consistent with the results of the prior studies (replicating the results of the pilot study and coherent with the interpretation results of the immediately preceding study).

    The mean reading times in ms are presented in Table 8 and Figure 7.

    Both main effects and their interaction were significant. Clauses containing pronouns took longer to read than clauses containing elided VPs ($b = –112.39, t = –3.77$).[12] This cannot be interpreted since it might be due to the pronoun items being slightly longer on average. Distant items took longer to read than local items ($b = 70.34, t = 4.30$), as expected. Most interesting is the interaction: the distance penalty is greater with ellipsis than with pronouns ($b = 46.06, t = 3.58$). Again this is expected if the ellipsis examples require a syntactic antecedent.

Table 7: Mean naturalness ratings (1–7) (with standard errors).

	–Distant	**+Distant**
Pronoun	**6.06** (0.08)	**5.16** (0.08)
Ellipsis	**6.17** (0.11)	**4.73** (0.11)

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[12] All reading time data are analyzed with linear mixed-effects regression on raw reading times, with Participant and Item as random predictors, using the *lmer* package in *R*. We report the estimated slope and t score for all predictors of interest.
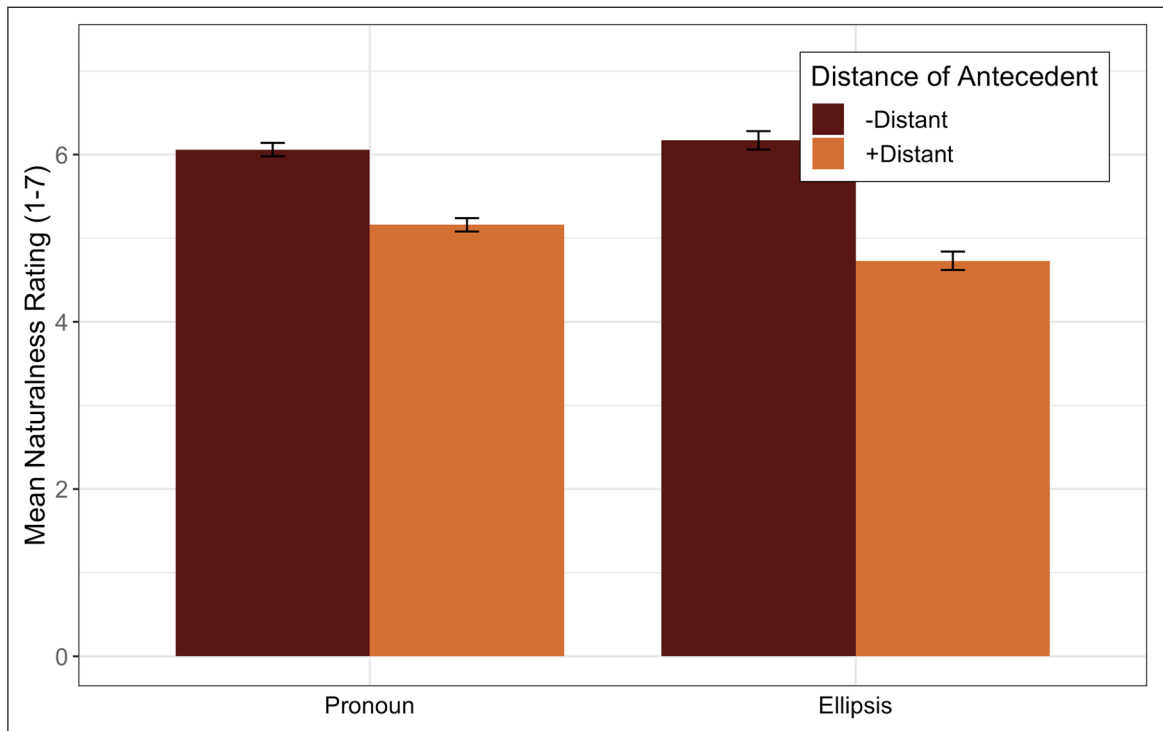
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Figure 6: Mean naturalness ratings (1–7) (with standard errors) from Experiment 5.

Table 8: Mean reading times on final sentences (ms) (with standard errors).

	Local	*Distant*
Pronoun	**565** (25)	**622** (25)
Ellipsis	**358** (18)	**505** (23)
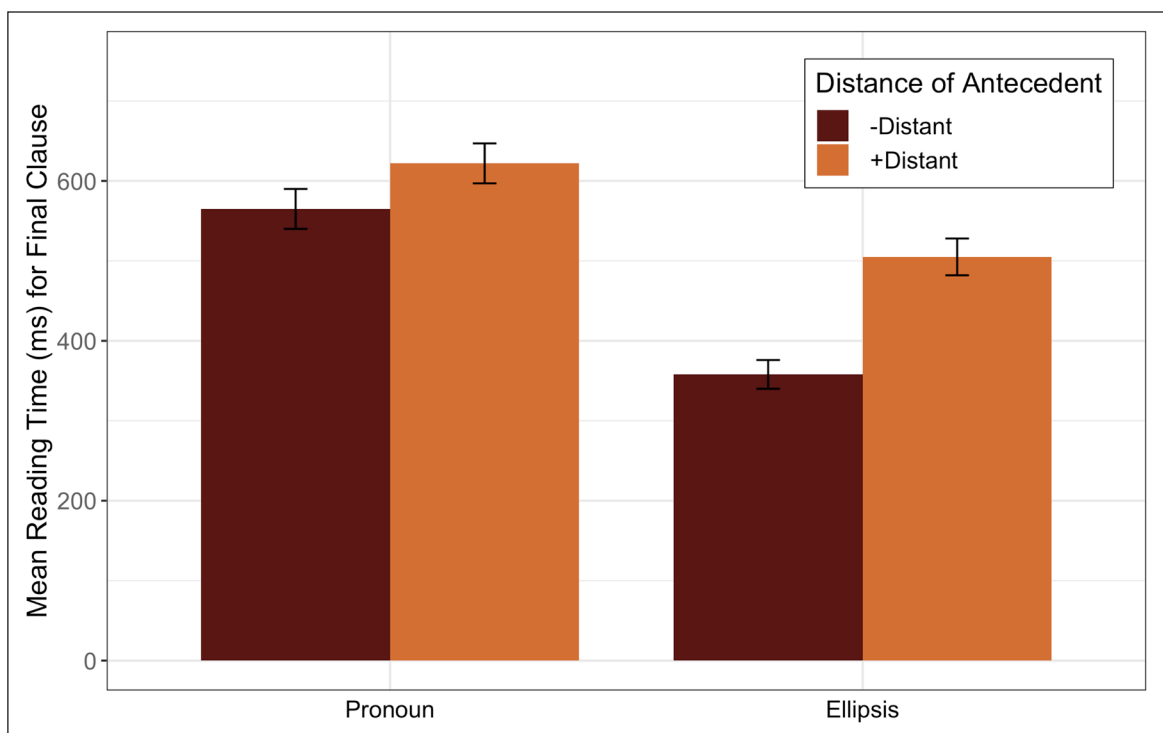
Figure 7: Mean reading times on final sentences (ms) (with standard errors) from Experiment 5.

4.3 Experiment 6: Interference effects in antecedent choice?

We turn now to an issue about the underlying source of the rating and reading time cost for distant antecedents. One possibility is that it is due to retrieval difficulty: in the distant conditions there may be similarity interference effects from the presence of a potential antecedent for the elided VP (see Lewis, Vasishth & Van Dyke 2006; Martin & McElree 2008). If so, given that *do* VP ellipsis cannot have an antecedent with a *be* auxiliary, then an intervening *be*-auxiliary VP, not a potential antecedent, should impose a smaller distance penalty than a suitable antecedent VP. This was systematically manipulated in the next experiment using examples like those in (14). If, on the other hand, the distance effects are due to what is currently active in syntactic memory, then the presence of a *be* auxiliary in the intervening clause shouldn't matter.

4.3.1 Method and materials

As a preliminary test of these possibilities, 40 MechanicalTurk users were tested on 20 sentences like those in (15) in a self-paced reading study with a following interpretation question, with a forced choice answer. The items were two sentence discourses, with VP ellipsis in the second sentence. The first sentence contained a though-clause with (15a, b) or without (15c, d) *be* (±*be*), thus being an impossible or possible antecedent for the ellipsis. The position of the though-clause was also manipulated, highlighted here by boldface: it appeared at the beginning of the first sentence (–Intervening) (15a, c) or at the end of the first sentence (+Intervening) (15b, d).

(15)　　Region 1 | Region 2 | Region 3
    a.　**Though the global economy was uncertain due to the recession**, | Carl went to college but Bill dropped out. | Sally did too.　　　　　　　　　　(+*be*, –Intervening)

    b.　Carl went to college but Bill dropped out, | **though the global economy was uncertain due to the recession.** | Sally did too.　　　　　　　　(+*be*, +Intervening)

    c.　**Though the recession brought on economic uncertainty across the globe,** | Carl went to college but Bill dropped out. | Sally did too.　　　　　　　(–*be*, –Intervening)

    d.　Carl went to college but Bill dropped out, | **though the recession brought on economic uncertainty across the globe.** | Sally did too.　　　　　(–*be*, +Intervening)

What did Sally do? ["Sally went to college.", "Sally dropped out."]

We excluded 8 participants from analysis for average response times faster than 1000ms. All participants were compensated with $1.20 for about 10 minutes of work.

4.3.2 Results and discussion

The results of the interpretation choices are presented in Table 9 and Figure 8 in terms of the percent "initial" VP/*went to college* antecedents. Clearly participants preferred the VP in the *but*-clause as the antecedent overall (the complement of the "initial" antecedents, so 71% or higher). The effect of the intervening *though*-clause was significant ($b = -0.96$, $z = -3.88$, $p < .001$); no other effect or interaction was significant including the presence of *be* in the intervening VP ($b = 0.16$, $z = 0.77$, $p = .440$). In short, participants preferred the second, *but*-clause antecedent and there was no difference between licit-antecedent and illicit-antecedent intervening material. Note further that while the *though* clause had an indefinite subject, the clause like *Sally brought on economic recession* is perfectly grammatical even if implausible.

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Table 9: Percent "initial" VP (went to college) antecedents (with standard errors).

	+be	**−be**
−Intervening	**28.1** (3.7)	**28.8** (3.6)
+Intervening	**11.9** (2.6)	**15.0** (2.8)
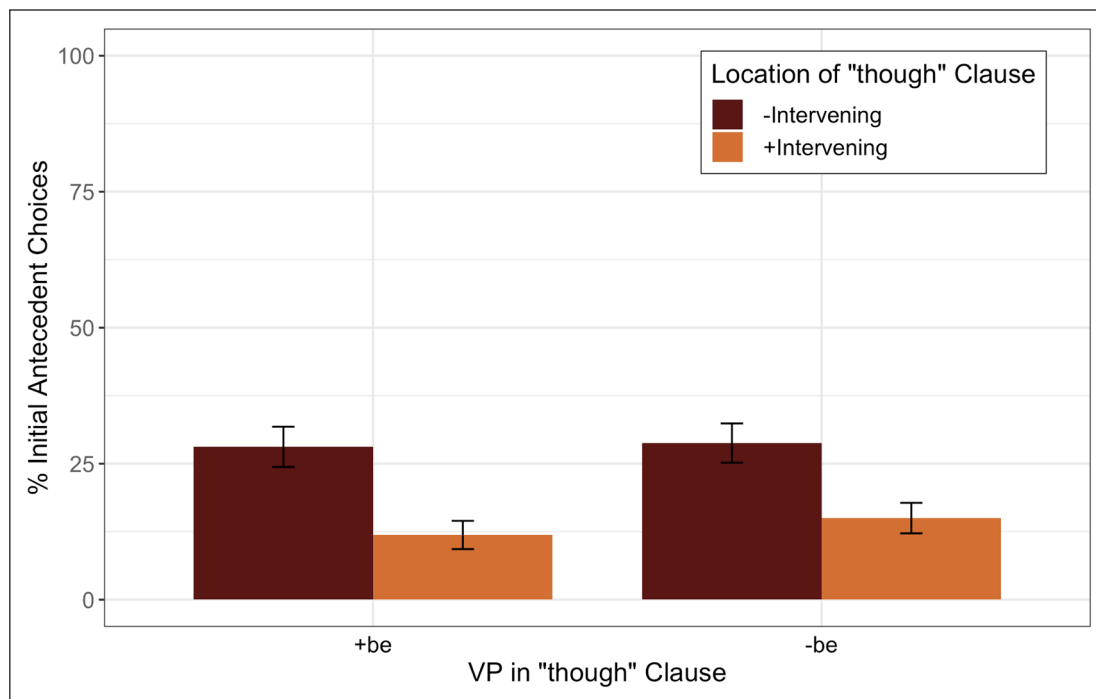
Figure 8: Percent "initial" VP antecedents (with standard errors) from Experiment 6.

The reading times are presented in Table 10 and Figure 9.

Similar to the interpretation results, the effect of distance was significant ($b = 0.06$, $t = 2.33$); no other effect or interaction was.

4.4 General discussion

We have seen distinct effects of distance for discourse anaphora and VP ellipsis. Given independent evidence that recency influences the salience or accessibility of phrases in syntactic representations, e.g., for parsing phrase structure (e.g., Gibson et al. 1996) and gap filling (Dillon 2019), the greater effects of distance for VP ellipsis than for pronouns fits with our assumption that VP ellipsis requires a syntactic antecedent whereas discourse anaphoric pronouns do not.

The distance effects observed in Section 4 also help us to sketch a plausible hypothesis about what is in ASM. What we suggest is that the processor devotes resources to maintaining the current clause/sentence and the last potentially independent clause in ASM. Assuming the syntactic representation decays over time, the representation of material in other clauses will persist primarily in a discourse representation and situation model. Given particularly long and complex clauses, the proposed limits of ASM may exceed the capacity of an individual. But with short clauses, we think our proposal is a reasonable approximation.

The critical interaction observed in the experiments reported in Section 4 between type of dependency (pronoun vs ellipsis) and the distance of the antecedent might receive an explanation in some terms other than whether the required antecedent is found in the syntactic representation or the discourse representation. For example, perhaps the semantic type of

Table 10: Mean reading times for the ellipsis clause (ms) (with standard errors).

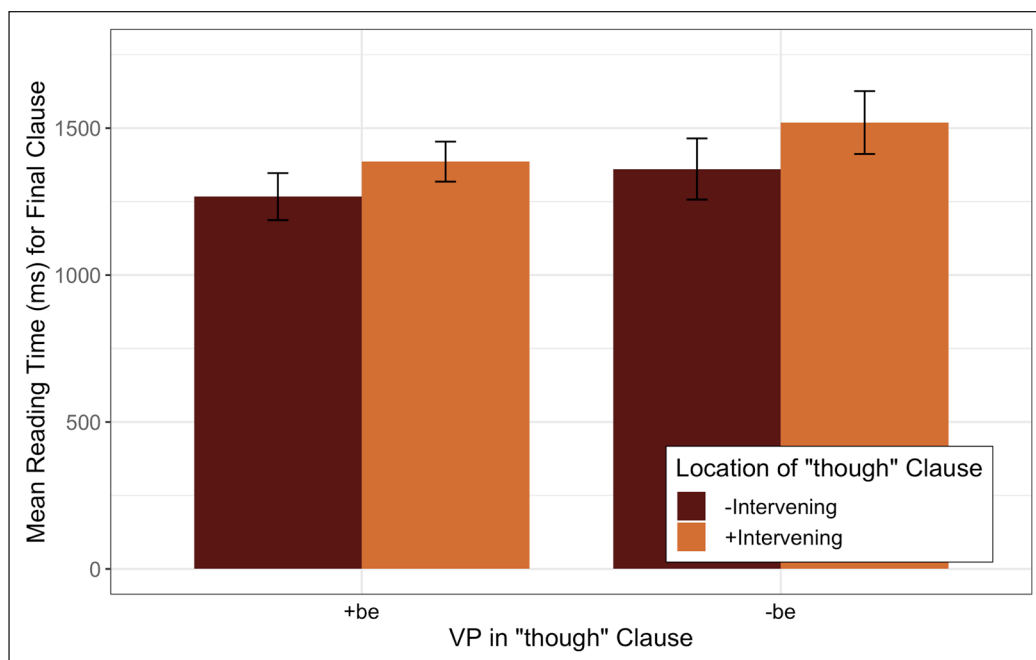|	**+be**	**−be**
−Intervening	**1267** (80)	**1361** (104)
+Intervening	**1386** (68)	**1519** (107)

Figure 9: Mean reading times for the ellipsis clause (ms) (with standard errors).

the antecedent is critical: the antecedent for the pronoun was an animate of the semantic type "entity" whereas the antecedent of the ellipsis was a higher order type ("property"). Perhaps higher order types do not persist as long in memory as do lower types.

Although an alternative account based on semantic type is possible in principle and sounds quite plausible, we note that to our knowledge no explicit evidence has been presented to support a negative correlation between higher semantic types and longer persistence in memory. Indeed, decades ago, the first author and Keith Rayner did an (unpublished) eye movement study to look for just such a correlation between reading times and the complexity of semantic types, specifically intensional vs extensional verbs. We were unable to establish a difference; nor was there a difference in coordination structures depending on whether the higher or the lower type came first (as might have been expected, assuming a like semantic category constraint on coordination, if receiving the lower type first resulted in a semantic garden path due to the failure to type raise the extensional verb when it was first encountered, a problem that would be averted when the intensional verb came first).[13]

5 The circumstances of repair

The results of the studies in Section 4 suggest that what is readily accessible in ASM is the current clause and the last potentially independent clause.[14] We now return to the question of when the processor repairs an antecedent and when the processor accommodates

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[13] For comparison of personal pronouns, presumably of a lower type, and propositional *that*, see Göbel (to appear).

[14] In recent years, investigators have focused on cue-based memory models (Lewis, Vasishth & Van Dyke 2006; Martin & McElree 2008) and the question of how phrases are accessed from memory, assuming that all of

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an antecedent (in the sense of accommodating a proposition, not what might be called ellipsis accommodation, e.g., Thoms 2015, which to the extent that it is dependent on the **form** of a phrase, resembles repair[15]).

(16)   **Hypothesis:** Repair takes place when a nearly-matching antecedent is available in ASM.[16]

The hypothesis in (16) is intended to supplement and not replace the conditions on repair already noted in the description of the recycling theory in the introduction. Note that (16) is clearly an idealization: clause/sentence size and complexity/integration clearly matter, and in reality the availability of a clause in ASM is likely a probability rather than absolute. In any case, we have presented preliminary evidence for the picture in Table 11, where depending on the status of the recent clause (S2) it will be more available than the first clause (S1) when it is a potential independent clause (*but*) not when it is clearly dependent (*after*). When clauses make up full sentences, then unsurprisingly they will also be more available than a prior sentence.

Given our assumption that discourse anaphoric pronouns find an antecedent in the discourse representation and that elided constituents take antecedents in the syntax when one is available in working memory, we can give a coherent account of the results just summarized. Further we would expect that the presence of an intervening sentence would influence the probability of repair.

5.1 Experiment 7: Naturalness of recycling or accommodating a distance antecedent

To test the prediction that an intervening sentence should make an antecedent less accessible, we returned to the recycling sentences of Arregui et al. (2006), given in (17). According to Arregui et al., the sentences in (17a, b) are grammatical: there is a syntactically matching antecedent in both cases, just embedded under a nominal in the case of (17b). (17c, d) were analyzed as being ungrammatical because no matching antecedent exists, but (18c) was somewhat acceptable because it could be repaired. (17d) was analyzed as both unacceptable and ungrammatical since it would be necessary to build a VP from

Table 11: A schematic for the representational availability of S1 and S2 given certain utterances.

	Discourse Representation	*Syntactic Representation*
S1 *after* S2.	**S1**	**S1, S2**
S1 *but* S2.	**(S1) S2**	**S2**
S1. S2. *But J did.*	**S2**	**S2**

---

memory is accessed. In the early days of psycholinguistics, the emphasis was instead on what is available to be accessed. To our knowledge the ASM hypothesis is broadly consistent with these early results (Fodor, Bever & Garrett 1974). What we suspect is that understanding memory for sentence processing requires both identifying what material is available to be accessed and looking at how subparts of representations are accessed in whatever representations are available.

[15] In an analysis of scalar implicatures, Katzir (2007) proposed that alternatives may be at most as complex as the original expression. In his analysis of ellipsis, Thoms (2015) builds on this theory of alternatives, allowing deletion, contraction and substitution as operations defining admissible alternatives. These alternatives may serve as antecedents for elided constituents. Since these operations are limited by the **form** of the original expression, they do not really count as a clear case of accommodation in the sense relevant for the present discussion. Rather they straddle the present categories of repair vs accommodation. See also Paape (2016) for evidence suggesting that antecedents should not be treated as word strings that can be reparsed.

[16] Brian Dillon points out that this hypothesis is similar to the hypothesis defended in the text processing literature claiming that inferences beyond those needed to establish coherence are only drawn when they involve local material available in working memory (McKoon and Ratcliff 1992).

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scratch to obtain a matching antecedent.[17] The question is whether the presence of an intervening sentence, as in (17′), influences grammatical and ungrammatical conditions differently. For the grammatical examples, we expect a penalty, lower acceptability, for the distant conditions in (17′) compared to the local conditions in (17). For the unacceptable ungrammatical example, we expect that making the ungrammatical antecedent less accessible may actually improve the example. For (17c) and (17′c) the prediction is less clear: to the extent that the antecedent is less accessible it may be harder to repair the antecedent, decreasing acceptability; however, making the antecedent less accessible may also serve to minimize the ungrammaticality. Possibly there will even be a mixture of these two effects, resulting in a distance effect that is intermediate between the grammatical conditions and the unacceptable ungrammatical condition.

5.1.1 Method and materials

66 MechanicalTurk users, divided into two groups, were asked to rate the naturalness of 16 passages on a scale of 1 to 7. Each group saw either passages like (17), with local antecedents, or passages like (17′), with distant antecedents, with both groups seeing all four of the Arregui et al. antecedent conditions.

(17)　　Group 1: Region 1 | Region 2
  a. None of the astronomers saw the comet, | but John did.
                (Available VP, –Distant)
  b. Seeing the comet was nearly impossible, | but John did.
                (Embedded VP, –Distant)
  c. The comet was nearly impossible to see, | but John did.
                (VP + Trace, –Distant)
  d. The comet was nearly unseeable, | but John did. (Adjective, –Distant)

(17′)　　Group 2: Region 1 | Region 2 | Region 3
  a. None of the astronomers saw the comet. | It was so cloudy. | But John did.
                (Available VP, +Distant)
  b. Seeing the comet was nearly impossible. | It was so cloudy. | But John did.
                (Embedded VP, +Distant)
  c. The comet was nearly impossible to see. | It was so cloudy. | But John did.
                (VP + Trace, +Distant)
  d. The comet was nearly unseeable. | It was so cloudy. | But John did.
                (Adjective, +Distant)

Distance was adopted as a between-participant manipulation in order to allow us to maintain the original set of 16 items from Arregui et al. without reducing the number of observations per cell below 4. As throughout, participants saw only one sub-list, seeing each of the 16 experimental items.

18 participants were excluded from the sample for average ratings of greater than 3.5 for ungrammatical filler items, leaving a sample of $n = 48$. All participants were compensated $1.00 for about 8 minutes of work.

5.1.2 Results and discussion

The results are presented in Table 12 and Figure 10.

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[17] A reviewer asks why (20d) is not completely out if it is unacceptable and ungrammatical. In the Arregui study it received 17% yes responses. This could be due to errors where participants don't pay attention or press the wrong button.

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Table 12: Mean naturalness judgements (1–7) (with standard errors).

		−*Distant*	+*Distant*
a.	Available verb phrase	**6.0** (0.1)	**5.6** (0.1)
b.	Embedded verb phrase	**5.2** (0.1)	**4.7** (0.2)
c.	Verb phrase with trace	**4.6** (0.2)	**4.5** (0.2)
d.	Negative adjective	**3.3** (0.2)	**3.5** (0.2)
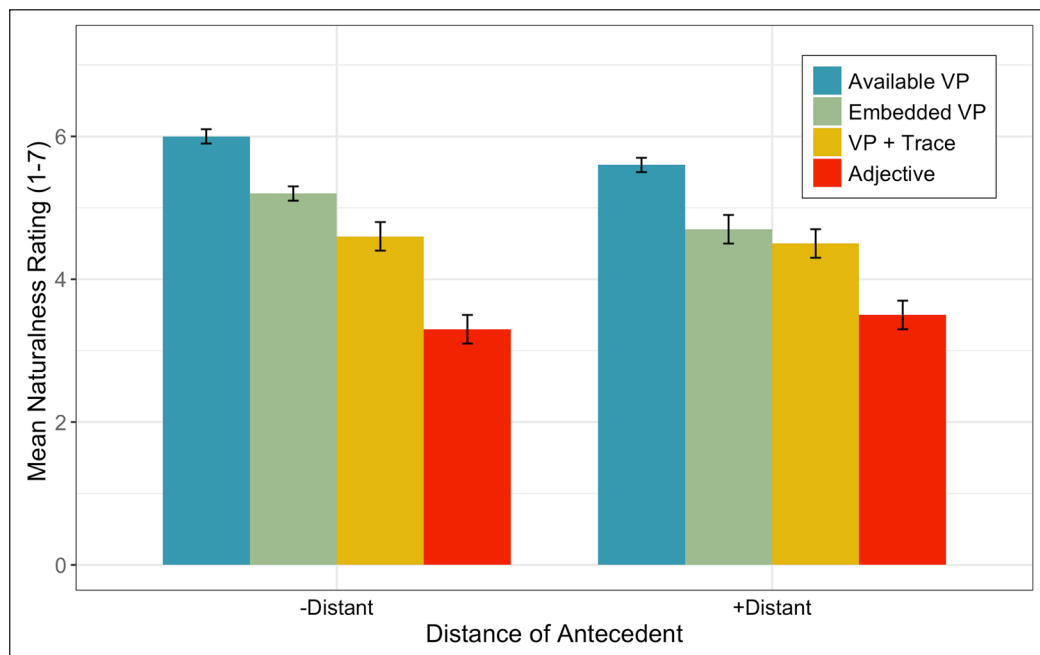
Figure 10: Mean naturalness judgements (1–7) (with standard errors) from Experiment 7.

The full range of difficulty effects, examined through reverse Helmert contrast, was significant (a vs b: $b = -0.43$, $z = -5.01$, $p < .001$; a/b vs c: $b = -0.25$, $z = -5.61$, $p < .001$; a/b/c vs d: $b = -0.34$, $z = -8.27$, $p < .001$), and there was an only barely-significant interaction of distance and the final difficulty step between the first three conditions and the adjective condition ($b = 0.11$, $z = 1.96$, $p = .050$).

We don't consider the crucial interaction reliable evidence as to our predictions, but present a post-hoc analysis combining the grammatical conditions (Available VP, Embedded VP) (a, b) and ungrammatical conditions (VP + Trace, Adjective) (c, d), to more directly target the most important prediction: that distance should affect the grammatical (a, b) ellipsis conditions differently than the ungrammatical (c, d). This analysis, depicted in Table 13 and Figure 11, found a significant effect of ungrammaticality ($b = -1.00$, $z = -9.14$, $p < .001$) and an interaction with locality ($b = 0.30$, $z = 2.00$, $p = .046$).

Qualitatively, it looks like conditions (a) and (b) are penalized by distance, (c) is unaffected (though histograms show a 10% increase in "4–5" responses in the distant condition), and (d) actually gets numerically better (histograms show the distant conditions lose a substantial amount of "hate" responses "1,2,3").[18,19]

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[18] We also collected and analyzed reading times on the final clause. The only significant reading time effect is the comparison of reading times for VP with trace compared to the available and embedded VP conditions ($b = 17.69$, $t = 2.83$).

[19] It is possible that (17′c) exhibits a mixture of facilitation from distance, because it is ungrammatical, and interference from the lesser availability of material needed for a repair. Further work is needed to determine exactly what is going on.

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Table 13: Mean naturalness judgments (1–7).

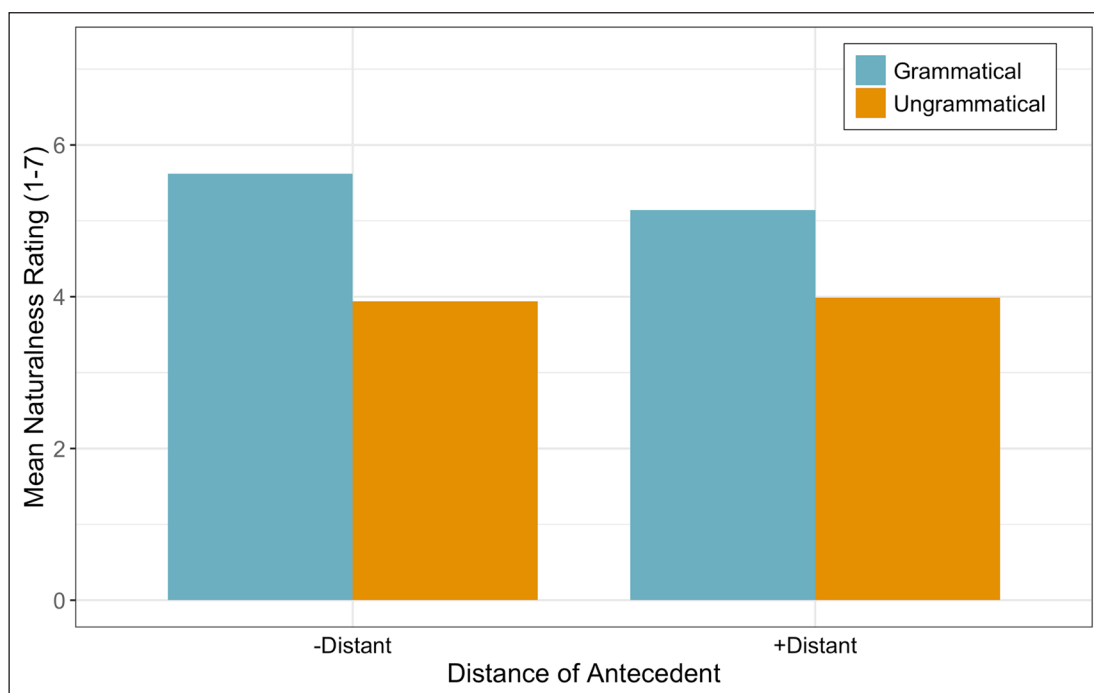|	*−Distant*	*+Distant*
Grammatical	5.62	5.14
Ungrammatical	3.94	3.99

Figure 11: Mean naturalness judgements (1–7) grouping only by grammaticality.

In sum, the effect of distance varied along with the structural condition with an apparent rating penalty for distant conditions for grammatical sentences, and a slight increase in ratings for unacceptable ungrammatical sentences when distant. Acceptable ungrammatical sentences show a smaller effect in ratings. Further investigation will be necessary before we truly understand the underlying processes giving rise to the variation observed across these distance effects.[20]

A reviewer further suggests that polarity focus and subject focus VP ellipsis may show distinct distance effects (Miller 2011) possibly predicting further differences in the effect of manipulating distance.

[20] We could compare the sizes of the penalty for voice mismatches in simple VP ellipsis and split antecedent VP ellipsis, as pointed out by a reviewer, who supplied the examples below.

(i)   This year, Bob climbed Kilimanjaro and Susan hiked the entire Appalachian trail. I'm surprised they were each able to.
(ii) This year, Kilimanjaro was climbed by Bob and the entire Appalachian trail was hiked by Susan. I'm surprised they were each able to.

The prediction is that the mismatch penalty in (ii) should be smaller than in (ii) than in (iv). For what it's worth, ratings supplied by four individuals (including the authors) supported the prediction.

(iii) This year, Bob climbed Kilimanjaro. I'm surprised he was able to.
(iv) This year, Kilimanjaro was climbed by Bob. I'm surprised he was able to.

However, the reason why we have not carried out such a study is that there is a problem interpreting such ratings because the split examples are also in a lower range of the scale, and thus might show smaller differences for this reason alone.

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6. Summary and Conclusions

In this paper we have pursued a repair account of VP ellipsis based on the assumption that the grammar requires syntactic matching of antecedent and elided VP. We note that larger effects of matching are observed in items containing ellipsis than counterparts without ellipsis (Tanenhaus & Carlson 1990; Kim et al. 2011; Miller & Hemforth 2014; among others). This is not surprising if ellipsis grammatically requires a matching antecedent.

The present studies also show that the distance between antecedent and anaphor/ellipsis site matters more for ellipsis than for discourse anaphora, as would be expected if ellipsis requires a syntactic antecedent whereas for discourse anaphora an entity (discourse referent) in the discourse representation would suffice.

We present new evidence concerning ASM. Our experimental results show that the connective matters: a coordinate clause with *but* acts like an independent clause, reducing the accessibility of preceding clauses more than a subordinate clause with *after* does. This fits with a view where ASM typically has ready access to the syntactic representation of the current clause and the last potentially independent clause. Of course, in actuality it will matter how long and complex clauses are; the claims we make here are clearly idealizations approximating the behavior of the human processing system with input that is not particularly complex.

The position of an adjunct clauses also mattered in our study, and it interacted with the type of "anaphor" (ellipsis vs pronoun). An intervening *though* clause mattered more for ellipsis than for a pronoun. This interaction again suggests that it is the availability of a syntactic representation of the antecedent that matters for ellipsis more than for a pronoun.

Although it is only suggestive, we presented evidence that the present memory effects, and the difference between ellipsis and pronouns, are not due to cue-based retrieval: no difference in the effect of an intervening clause was observed based on whether the clause included a licit or illicit VP-ellipsis antecedent.

Finally, initial evidence suggested that grammatical examples of ellipsis and acceptable ungrammatical examples, and unacceptable ungrammatical examples respond differently to manipulations placing their antecedent outside ASM. There were indications that the grammatical examples became worse with the presence of an intervening sentence, whereas the unacceptable ungrammatical examples got slightly better. The implication is that the syntactic form of the antecedent required for repair is not reliably available in distant antecedent examples including cases of split antecedent ellipsis.

Turning to relevant properties of memory, we have presented evidence that ASM typically includes the last potentially independent clause. Repair takes place when a mismatching antecedent (small mismatch, lots of evidence…) is present in ASM. Standard cases of split antecedent ellipsis will involve source material too far away for systematic repair.

Once a role for accommodation has been recognized, one might wonder why anything else (repair) is needed? Why not just assume that accommodation is responsible for all ellipsis processing? The answer comes in three parts. First, empirical evidence suggests the existence of form-based effects indicating that distance from the matching form influences the level of acceptability of mismatch ellipsis. Arregui et al. present various studies of this sort, e.g., if the antecedent for VP ellipsis is a verbal gerundive a sentence is rated more acceptable than a counterpart where the antecedent is a nominal gerundive.

Second, there is evidence that the grammar requires syntactic matching between antecedent and elided constituent (see Kim & Runner 2018 in particular). Many studies show that the effect of a syntactic mismatch between an antecedent clause and a subsequent conjoined clause is larger in sentences containing ellipsis in the second clause than in sentences with the full VP: Grant et al. (2002), Miller & Hemforth (2014), Kim & Runner

(2018), Clifton et al. (2019) (or sentences with a pronoun, Tanenhaus & Carlson 1990). As Kim & Runner (2018) argue, presence of a mismatch effect just for sentences with ellipsis argues for a matching constraint in the grammar. On this assumption, then one need only assume that **the processor, as always, attempts to find a grammatical analysis of the input.** When the antecedent for an elided constituent does not match perfectly, then a repair takes place.

Third, when the syntactic form of an antecedent is by hypothesis not available to be repaired, the processor, as is usual, does not just give up but rather attempts to make sense of the input. These are cases we have labelled as "accommodation", but there seem to be limits as shown below. Accommodation seems to take place only with vary specific types of context or extremely rich contexts. In the classic split-antecedent ellipsis examples of the type studied by Webber (1978), there are semantically parallel conjuncts which easily give rise to a superordinate predicate (e.g., what they wanted to do). Indeed, the superordinate relation might be inferred simply as part assigning a similarity coherence relation to the conjunction (Kehler 2002), and thus it might be available before the ellipsis clause was even encountered. Although a full account of the limited circumstances allowing accommodation of an antecedent goes beyond the scope of the present paper, it is clear that once the possibility of a superordinate relation is eliminated, a split antecedent becomes very difficult indeed, as in (19).

(19)   #John argued that the university should reduce the amount of university bureaucracy although/and Sam was arguing for only trained assistants to be allowed to update websites, and the administration did too.

The content of the conjuncts in (19) is loosely contradictory and thus a similarity relation is not invited (this can be demonstrated by the acceptability of *although* as the conjunction). Repair should not be possible in this case because some of the source material is outside active syntactic memory. But accommodation also seems not to be possible.

In sum, the evidence we've presented here compels a theory of mismatch ellipsis which cannot be solely either repair or accommodation, but instead must recognize some condition which governs when the processor turns to one or the other, and when neither mechanism will succeed. We think the data support the limitations on ASM proposed here as being exactly such a condition. As to why repair is needed once a role for accommodation is recognized, we submit that this is because the human language processor always tries to find a grammatical analysis of linguistic input, and it uses a grammar that requires syntactic matching of an elided constituent and its antecedent.

Abbreviations
ASM = Activated Syntactic Memory, DP = determiner phrase, QUD = question under discussion, VP = verb phrase, VPE = verb phrase ellipsis

Additional File
The additional file for this article can be found as follows:

- **Supplementary file 1.** Materials from the experiments reported in "Repair or accommodation?" DOI: https://doi.org/10.5334/gjgl.728.s1

Ethics and Consent
All experiments were conducted in accordance with the approval of the UMass Amherst Institutional Review Board, approval number #2102-1360.

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Competing Interests

The authors have no competing interests to declare.

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