Reconstruction in Wh-Movement: The View from Lexical Reactivation

Abstract. A point of contention in the syntactic literature is the question of whether any NP-internal material besides the head N itself reconstructs in A-bar movement configurations such as WH questions. Previous literature has examined Condition C effects in pronoun interpretation, looking at whether part of the moved NP can be co-valued with a pronoun in subject position. There is general agreement that head nouns reconstruct and that adjuncts do not, but whether complements pattern with heads or with adjuncts in this regard remains unsettled. We conducted a novel forced-choice decision experiment designed to probe reactivation of lexical material at a gap site. Our findings indicate that only the head N is reactivated, and that complements pattern together with adjuncts in not showing any evidence of reactivation at the gap site. Tying this outcome together with earlier work on reconstruction, we arrive at the view that only head nouns reconstruct but their complements and adjuncts do not.

1. Introduction

An important issue in syntactic theory has been the relation between movement and binding. This has often been discussed under the heading of "reconstruction," where part or all of a moved phrase acts like it is in its pre-movement position for syntactic phenomena like binding. Reinhart and Reuland (1993) argued that apparent instances of reconstruction for Binding Condtion A like that in (1) do not actually require reconstruction; apparent anaphors inside of moved NPs are actually logophors. That they can be is confirmed by examples like (2), where there is no binder for the "anaphor" in the sentence in which it occurs (see also Pollard and Sag 1992, Fox and Nissenbaum 2004).

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(1) How many pictures of herself$_1$ did Susan$_1$ take — in the pub?

(2) Susan was perturbed. How many pictures of herself were taken in that pub, anyway?

Most of the recent literature has concentrated on Binding Condition C instead, where logophoric uses of anaphors are not at issue. A disagreement over data has arisen that has led to a flurry of experimental work in the last few years. This work has specifically addressed the question of whether there is reconstruction of complements and adjuncts of NPs that have undergone wh-movement, as diagnosed by Binding Condition C. The key point of contention is illustrated by the example in (3), in which the object complement of the verb *resent* is A-bar moved.

(3) Which investigation of Trump did he resent the most? (based on Safir 1999: 589, note 1)

The point of disagreement is whether the pronoun *he* can be covalued with an R-expression in the complement of the N, here *Trump*. At stake theoretically is whether all of the content of the moved wh-NP reconstructs, or only some of it does. If all of it does, we have a representation like in (4), with struck through material not pronounced but visible to the syntax (and semantics).

(4) Which investigation of Trump did he resent ~~which investigation of Trump~~ the most?

In this representation, if *he* is covalued with *Trump*, there is a violation of Binding Condition C. Binding Condition C forbids an R-expression like *Trump* from being covalued with an NP that c-commands it. The pronoun *he* c-commands the lower copy of *Trump* in this representation.

An alternative is that less material is present in the gap site, for instance just the head of the moved NP (perhaps with a determiner), as shown in (5).

(5) Which investigation of Trump did he resent ~~(the) investigation~~ the most?

In this alternative representation, *he* does not c-command *Trump*, and so covaluation should be possible.

However, the empirical facts themselves are heavily debated. Based purely on informal judgments, van Riemsdijk and Williams (1981), Freidin (1986), Barss (1988), Lebeaux (1988), Chomsky (1993), Sauerland (1998), Safir (1999), Fox (1999), Takahashi and Hulsey (2009), among others, claim that covaluation between the pronoun and an R-expression contained in a complement to a wh-moved NP is *not* allowed. These authors also claim that there is a difference between complements of a moved N, and adjuncts. They state that covaluation *is* permitted if the R-expression is contained in an adjunct rather than a complement, as in (6).

(6) Which investigation near Trump's house did he resent? (based on Safir 1999: 589, note 1)

On the other hand, Bianchi (1995), Lasnik (1998), Kuno (2004), Henderson (2007) suggest that the contrast between (3) and (6) is not very strong and may not even exist. These authors give numerous examples where, according to them, covaluation between a pronoun and an R-expression contained in a complement to a moved N is permitted, and even preferred.

The more recent experimental literature addressing this question has mostly found that covaluation *is* possible. Leddon and Lidz (2006) found that adults permit covaluation in examples like (3) 23% of the time (while children overwhelmingly prefer the covalued interpretation). Adger et al. (2017) also found that adults accepted the covaluation interpretation. They also found an effect of linear distance, such that participants were more likely to permit covaluation the greater the distance was between the fronted NP and the pronoun. Bruening and Al Khalaf (2019) found that native speakers chose the covaluation interpretation in a forced-choice task at relatively high rates, with both PP and CP complements of moved Ns. On the other hand, Stockwell et al. (2021, 2022) claimed to find that participants do *not* permit covaluation in examples like (3), but do in examples like (6).

Note that all of this research has looked only at the question of whether covaluation is possible. When it is judged not to be, that does not necessarily mean there is reconstruction leading to a Condition C violation as in the representation in (4). As pointed out by Bruening and Al Khalaf (2019), covaluation could be dispreferred for pragmatic rather than syntactic reasons. As is well-

known in the pragmatic and psycholinguistic literature, there are many non-syntactic factors that affect how listeners resolve an anaphoric pronoun, such as in (7) (Chafe 1976, Sheldon 1974, Ariel 1990, Grosz et al. 1995, Chambers and Smyth 1998, Almor 1999, Kehler 2000, Arnold 2001, 2010, 2013, Rohde and Kehler 2014, a.o.). In (7), the pronoun *he* in the second conjunct can refer either to *Trump* or to *Pence* from the first conjunct.

(7) Trump called Pence and **he** asked a lot of questions. (adapted from Arnold 2010: 187)

Factors affecting speakers' choice of referent include grammatical function, with listeners showing a preference for subject co-reference over object co-reference (Gordon et al. 1993, Grosz et al. 1995); syntactic and semantic parallelism, where listeners prefer an antecedent that matches in its grammatical and/or thematic role with the pronoun (Sheldon 1974, Smyth 1992, Chambers and Smyth 1998, Kehler 2000, Frazier and Clifton 2006); and morphological parallelism, where a preference emerges for an antecedent that is case-matched with the pronoun (Tollan and Heller 2022). Most critically, however, recent work in this line of literature has shown that pronoun interpretation is also impacted by whether the antecedent is an argument or an adjunct: In an experimental study of reference resolution in Niuean (Polynesian, Austronesian), Tollan and Heller (2022) found that a pronoun in subject position (as per *he* in the examples in 3–6) triggers a preference for an antecedent in an adjunct position (i.e., an oblique-marked adjunct to an intransitive VP) compared with one in argument position (i.e., an oblique-marked complement to a transitive V). Conversely, when the pronoun was in object position, listeners showed the opposite preference, with arguments preferred over adjuncts as antecedents. Importantly, Tollan and Heller's (2022) experiment involved simple declarative sentences like in (7), where no reconstruction is involved. In short, there is evidence for a distinction between complements and adjuncts for pragmatic strategies invoked in resolving pronominal reference, outside of the syntax.

Going back to the examples in (3) and (6), we note that even if (some) speakers report a difference in pronominal covaluation judgements, this does not mean that there is reconstruction of the complement of the moved N. An alternative explanation is that certain English speakers show the same sensitivity to the complement-adjunct contrast in pronoun resolution that was observed

for Niuean speakers by Tollan and Heller (2022) — a matter which is orthogonal to the issue of whether syntactic reconstruction takes place or not.

Because of this, our present goal is to identify what material is present in the gap site in a manner that does not invoke pronoun resolution (or potentially logophoric uses of anaphors). We take an entirely novel approach, by looking instead for evidence of online reactivation of lexical material in the gap site in sentence processing. The idea is that, if there is reconstruction of all or part of the filler at the gap site, we should see evidence of reactivation of the lexical content of the filler. This technique follows the motivation for the original coining of the term "reconstruction": Namely, the logic that certain types of movement operations can be "undone" (see discussion in Barss 2001), and that this process of "undoing" reveals evidence of the pre-movement configuration — if such a representation is syntactically available. For instance, if the correct representation of (3) is that shown in (4), then we expect to see evidence of reactivation of both *investigation* and *Trump* at the gap site. If the right representation is instead that in (5), then we expect to see reactivation only of *investigation* and not *Trump*.

2. Experiment: Lexical Reactivation

We designed a novel lexical interference task, where participants read a sentence, and then are presented with two words. Their task is to identify which of the two words appeared *last* in the sentence. When applied to filler-gap dependencies, the idea is that, if there is reactivation of lexical material in a gap site (as shown in Wagers and Phillips (2014), among other works), we will see interference from a lexical item that is part of a filler, if the gap occurs *after* the other word choice. For example, in the sentence in (8a), the word *patient* came last, but *nurse* might be reactivated at the gap site after *with*. If it is, then we could see interference in the form of longer reaction times and/or lower accuracy, compared to a baseline with no filler-gap dependency, such as in (8b).

(8) a. Which nurse did the doctor say that the patient was unhappy with —?

b. The doctor said that the patient was unhappy with the nurse.

We applied this idea to test reconstruction of complements and adjuncts to nouns. Unlike

previous work on reconstruction, which only compares complements of nouns to adjuncts, we use a three-way comparison: the head noun itself, a complement to the noun, and an adjunct to the noun, as in (9). This allows us to compare the behavior of heads (as per 9a) with complements (9b), and complements with adjuncts (9c) in a single experimental paradigm.

(9) a. HEAD: the discussion **question**

b. COMPLEMENT: the discussion of a **question**

c. ADJUNCT: the discussion after a **question**

The lexical item at issue here is *question*. In the HEAD condition, it is part of a compound head noun. In the COMPLEMENT condition, it is the complement of the head N. In the ADJUNCT condition, it is an adjunct to the head N.

Applying this to the principle followed in (8) yields the paradigm in (10). Here, the word *question* appears before the word *relations*, but if there is reactivation of *question* after *relations* (i.e., at the hypothesized reconstruction site indicated with "—"), then we would expect participants to be slower and/or less accurate in their responses to the WH conditions in (10) than to the baseline conditions in (11).

(10) WH Conditions

a. WH-HEAD: The senators couldn't agree on which discussion **question** the important subcommittee on foreign relations should issue a statement about — first.

b. WH-COMPLEMENT: The senators couldn't agree on which discussion of a **question** the important subcommittee on foreign relations should issue a statement about — first.

c. WH-ADJUNCT: The senators couldn't agree on which discussion after a **question** the important subcommittee on foreign relations should issue a statement about — first.

(11) BASEline Conditions

a. BASE-HEAD: The senators couldn't agree on a discussion **question** when the important subcommittee on foreign relations issued a statement about cooperation.

b. BASE-COMPLEMENT: The senators couldn't agree on a discussion of a **question** when the important subcommittee on foreign relations issued a statement about cooperation.

c. BASE-ADJUNCT: The senators couldn't agree on a discussion after a **question** when the important subcommittee on foreign relations issued a statement about cooperation.

(12) (Question for both 10 and 11): Which word appeared last? Answer: QUESTION or RELATIONS

The baseline items (BASE) have a structure similar to the WH items and involving mostly the same lexical items, but the N *question* is now not part of a filler-gap dependency.

We expect reactivation to manifest as a longer reaction time to the question, "Which word appeared last in the sentence?" in the WH condition as compared to the BASE condition. We could (instead or in addition) find decreased accuracy in the response to this condition. All researchers agree that the head N reconstructs, so we minimally expect reactivation in the HEAD condition. This contrasts with adjuncts, which everyone agrees do not reconstruct; we therefore expect no reactivation effect for ADJUNCT. How COMPLEMENT will pattern is the open question: with HEAD (indicating that complements *do* reconstruct), or with ADJUNCT (indicating that they do not).

2.1 Method

We ran a forced-choice comprehension experiment, with a 2x3 within-subjects, within-items design. Two factors were manipulated: Movement (BASE vs. WH) and Position (HEAD vs. COMPLEMENT vs. ADJUNCT), corresponding to the tokens in (10–11).

2.1.1 *Materials*

We constructed 12 sets of items like those above (see Appendix for the full set of items). In the WH items, there were an average of 11 words between the filler and the gap, in order to give the initial activation of the filler time to decay (the number of words was based on cross-modal lexical priming experiments, e.g. Swinney 1991, Hickok et al. 1992, Love and Swinney 1996). The second word choice for the task was always part of the embedded subject, which comes between the filler and the gap in the WH items. Presentation order of the two response nouns was counterbalanced across items. The items were distributed among 6 lists, according to Latin Square. We coupled these with 12 filler items, six of which had an embedded *how* or *why* wh-question, such as (13a), and six of which were declaratives (e.g., 13b).

(13) a. Marketing managers need to understand how often consumers will be purchasing their products when determining production rate, transportation, storage, and so on. (consumers, transportation)

b. Scientists recovered the sample from the landing and the sample will be sent to the space center for examination and analysis. (landing, center)

2.1.2 *Participants*

208 participants recruited from Amazon's Mechanical Turk took part in exchange for $2US. We screened for L1 English speakers using demographic questions that were presented at the end of the experiment (we assume responses were truthful since payment was not contingent on how participants answered).

2.1.3 *Procedure*

The experiment was run via PC Ibex Farm (Zehr and Schwarz 2018). Participants were instructed to read each sentence. The sentence was presented in its entirety on the middle of the screen, and participants were not given any time limit for reading it. After reading the sentence, they pressed the space bar and the sentence disappeared. The probe question then appeared on the screen,

asking participants to identify which of the two words came last in the sentence. Returning to the previous display was not possible; thus, no re-reading of the sentence could take place. In order to encourage participants to read the sentences as carefully as possible, they were also informed that they would be asked to answer six randomly-interspersed Yes-No comprehension questions about the content of the sentences. These questions were displayed on a separate screen after participants had responded to the probe question. Again, it was not possible for participants to return to any of the previous display screens. The experiment lasted approximately 10 minutes.

2.2 Data analysis

Data from 2 participants was excluded because they did not self-identify as L1 English speakers, and data from a further 8 participants was excluded because they answered fewer than half of the Yes-No comprehension questions correctly.[1] Of the data from the remaining 198 participants, 209 trials (.09% of the dataset) were removed prior to analysis based upon the time that was taken to read the test sentence: Because these sentences were on average 20 words long, we removed trials with reading times of under 4000ms (an estimated mean by-word reading time below 200ms; n = 195). We also removed trials with long reading times of over one minute in total (n = 14).

We analysed the remaining 2,167 trials by fitting three 2 x 3 mixed-effects regression models. Each model had crossed random effects for participants and items (Baayen et al. 2008), and was fit using the lme4 package (R 4.0.2: Bates et al. 2015). Our first manipulation contrasted the WH conditions with the BASE conditions ("MOVEMENT," 2 levels) and was sum coded as +1/2 for WH and -1/2 for BASE. The second manipulation, noun type (three levels) was contrast-coded using centered Helmert contrasts. The first coefficient, HEAD, compared the head conditions (coefficient: +2/3) with the complement and adjunct conditions, pooled (coefficient: -1/3 for each). The second coefficient, COMPLEMENT vs. ADJUNCT, contrasted complements (coefficient: -1/2) with adjuncts (coefficient: +1/2): this contrast compares the complement and adjunct conditions

[1] We note that these comprehension questions were presented after an already-difficult task (i.e., the critical task, of recalling which word came last), rather than immediately after reading the sentence.. As expected, the mean accuracy for these comprehension question was low, at 78%, and so we chose a modest cutoff. Including all datasets (i.e., having no cutoff), or alternatively, excluding more participants based on higher cutoff thresholds, did not change the overall patterning of our data.

to each other, directly (the HEAD conditions do not participate in this comparison; their coefficient is 0). We used the maximal random effect structure justified by the experiment design that would allow for model convergence (Barr et al. 2013). *P* values were calculated via a Satterthwaite approximation, computed using the LmerTest function (Kuznetsova et al. 2017).

2.3 Results

We first analysed participants' accuracy in responding to the probe question (i.e., identifying which of the two words appeared last in the sentence). On average, participants answered this correctly 81.7% of the time, but the 2x3 logistic regression model revealed no significant main effects or interactions (all *p*s $>$ .13), meaning that participants' accuracy levels did not change as a function of our experimental manipulations.

Next, we analyzed time taken to respond to the probe question ("Which word appeared last?").[2] The mean RTs are shown in Figure 2. Descriptively, we note that only the Head condition is affected by the manipulation of movement; the complement and adjunct conditions are not. For the purposes of statistical analysis, these values were log-transformed and analysed via a 2 x 3 mixed-effects linear regression following the procedure described above.

We found a main effect of Movement, where RTs for WH conditions were slower overall than BASE conditions (4136ms vs. 4012 ms; β = -.014, *SE* = .007, *t* = -2, *p* = .048). There were no other significant main effects (both *p*s > .6). Most importantly, however, we find an interaction of Movement with HEAD vs. COMPLEMENT+ADJUNCT conditions, pooled (β = -.035, *SE* = .015, *t* = -2.4, *p* = .019), but critically no interaction of Movement with COMPLEMENT vs ADJUNCT (*p* = .98). The full model is shown in Table 1. We then unpacked the interaction by running a second model with MOVEMENT nested within noun type (this single model takes into account the variability in the full dataset). This model revealed a significant effect of movement for Head nouns, where movement triggers slower RTs (4164ms vs. 3846ms; β = -.04, *SE* = .01, *t*

[2]Because our analysis of response accuracy yielded no significant effects, we included RTs to all 2,167 trials in our analysis. As Wilson and Dillon (2024) note, all responses of this type are an attempt to complete the task, regardless of whether participants chose correctly or not. We ran a secondary analysis with response accuracy per trial included in the model, and found that it did not affect our main results. Therefore, we included all RTs in our analysis.

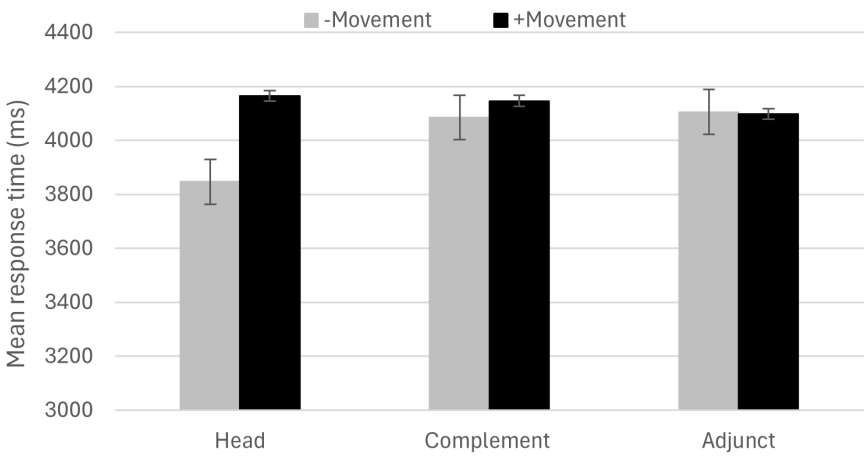

Figure 1: Mean response times for each level of noun type according to movement (+Movement WH in black bars; -Movement BASE in grey bars). Error bars indicate +/- 1 S.E.

= -3.1, p = .002), but not for complements or adjuncts (ps $>$ .84). [3]

Effect	β	*SE*	*t*	*p*
[Intercept]	3.56	0.02	224	<.0001
Head vs. [Complement+Adjunct]	-0.003	0.007	-0.4	.7
Complement vs. Adjunct	-0.004	0.009	-0.5	.61
Movement	**-0.01**	**0.007**	**-2**	**.048**
Head vs. [Complement+Adjunct] x Movement	**-0.04**	**0.02**	**-2.4**	**.019**
Complement vs. Adjunct x Movement	0.004	0.02	0.03	0.98
a) Noun = *Head*				
Movement	**-0.04**	**0.01**	**-3.1**	**.002**
b) Noun = *Complement*				
Movement	-0.0025	0.01	-0.2	.84
c) Noun = *Adjunct*				
Movement	-0.002	0.01	-0.17	.87

Table 1: The 2 x 3 mixed-effects linear regression model for RTs to probe questions (top part), along with the effect of Movement at each level of noun type (bottom part). Significant effects are bolded.

[3] A reviewer asks whether the absence of an effect in the COMPLEMENT and ADJUNCT conditions might reflect a processing bottleneck for the WH conditions here, because the response times to the BASE COMPLEMENT and BASE ADJUNCT conditions are already elevated (as compared with the BASE HEAD condition, where they are lower). There are two things that make this possibility unlikely: First, we might expect such a bottleneck effect to be coupled with lower accuracy for the COMPLEMENT and ADJUNCT conditions than the HEAD conditions. As we discussed above, however, we found no effects of accuracy. Second, the response times across the three WH conditions (mean 4135 ms) do not appear to reflect any sort of ceiling-level effect: Of our 12 fillers items, 4 of them (i.e., one-third) had response times *higher* than this threshold (from 4660 ms to 5340 ms).

2.4 Discussion

We find evidence that reaction time to identification of a target word is sensitive to interference due to lexical reactivation at gap sites. Critically, however, only the head noun causes this interference, complements and adjuncts to the noun do not. This indicates that only the head noun is reactivated at the gap site; neither complements nor adjuncts to the moved N are reactivated, since neither gave rise to an interference effect. There is, however, a potential alternative explanation for this result: Given that the NPs in the HEAD condition (e.g., *discussion question*) are less structurally complex than those in the COMPLEMENT and ADJUNCT conditions (e.g., *discussion of a question*, *discussion after a question*), it is possible that more time is required to read the sentences in the COMPLEMENT and ADJUNCT conditions (i.e., before participants exited the sentence display to respond to the probe question). This extra processing cost might well be enhanced in the sentences with WH movement, because one must hold the relevant WH filler (e.g., *which discussion of a question*) in memory before forming the relevant WH dependency. Critically for our present purposes, such extra reading time would lead to a better encoding of word order in the sentence, and this could have shortened participants' response times to the probe question independently of any reconstruction effects (or absence of them).

We examined this possibility by analyzing the time taken by participants to read the sentence displays (recall that these were presented in full). The mean reading times, by condition, are shown in Figure 2. Like with response times to the probe question, these response times were log-transformed prior to statistical analysis. There were two main effects: First, participants took less time to read sentences in the HEAD conditions compared with the COMPLEMENT+ADJUNCT conditions, pooled (10510ms vs. 10798ms/11318ms, β = -.026, SE = .007, t = -3.7, p = .0002). Participants also took longer to read sentences in the COMPLEMENT conditions compared with the ADJUNCT conditions, overall (β = .025, SE = .008, t = 2.6, p = .008). These differences in reading times are likely to reflect differences in the length of the sentences in the HEAD, COMPLEMENT, and ADJUNCT conditions, in which the HEAD conditions were generally the shortest

and the ADJUNCT conditions were the longest.[4] Returning to the overall sentence reading times, we note further that these reading time effects were across-the-board; that is, they occurred for both WH and BASE conditions, and therefore are not tied to WH-movement specifically. Importantly, neither of the two interactions was significant (*p*s $>$ .89), and in fact, the numerical trend for the interaction of HEAD vs. COMPLEMENT+ADJUNCT with MOVEMENT patterns in the opposite direction from what we would expect if the patterns in Figure 1 were driven by longer reading times for the COMPLEMENT and ADJUNCT conditions versus the HEAD condition, when WH movement occurs. (That is, numerically, participants took *more* time to read the sentences in the WH-HEAD condition than in the WH-COMPLEMENT and WH-ADJUNCT conditions by comparison with their BASE counterparts which do not involve movement.)

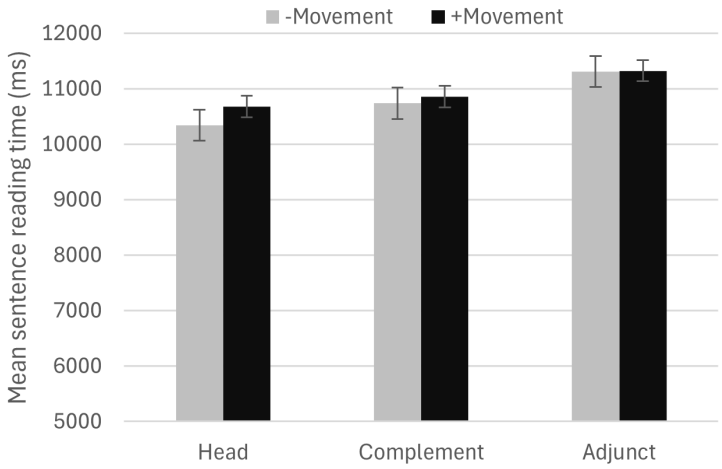

Figure 2: Mean sentence reading times by condition (+Movement WH in black bars; -Movement BASE in grey bars). Error bars indicate +/- 1 S.E.

In sum, it appears that our critical interaction for response time (see Fig. 1) is unlikely to be due to participants spending more time reading the WH-COMPLEMENT and the WH-ADJUNCT sentences compared with the WH-HEAD ones. We conclude that the most likely explanation for our findings is that only the head N is reactivated at the gap site.

[4]We checked this by also calculating an estimated mean reading time by-character for each critical trial, dividing the overall sentence time by number of characters in each sentence (not including spaces). Here, the mean estimated by-character reading time was 95ms and there were no significant main effects (all *p*s $>$ .12) or interactions (both *p*s $>$ .7), meaning that we find no evidence that character-reading time was different across any of the experimental conditions.

3. General Discussion

We found that only the head noun itself interferes in a lexical decision task, as measured by increased reaction times in participants' identification of a target word (i.e., the word which appeared last in the previously-presented sentence). As indicated statistically by a significant interaction of noun type and movement, this differs from the state-of-affairs for complements and adjuncts. Neither a complement to N nor an adjunct to N causes the slowdown that heads do. We take this to indicate that only the head noun itself is represented at the gap site. This is most consistent with a syntactic representation like that in (5), repeated below:

(14) Which investigation of Trump did he resent ~~(the) investigation~~ the most?

In this section, we discuss the implications of this result regarding two issues: Condition C reconstruction, and the theoretical representation of movement.

3.1 Condition C Reconstruction

As discussed above, there is currently a debate regarding whether complements inside moved NPs reconstruct for Binding Condition C. We have found that the complement to an N is not reactivated at the gap site. This finding is consistent with the majority of the experimental work on reconstruction for Binding Condition C in English, which found that neither complements nor adjuncts to N triggered a Condition C effect. It is not consistent with Stockwell et al. (2021, 2022), who claimed to find reconstruction of complements for Condition C. However, it should be noted that both of these works only compared complements and adjuncts to each other, and did not compare either of those to a baseline without wh-movement. Finding a difference between complements and adjuncts does not show that complements reconstruct for Binding Condition C. Stockwell et al.'s (2022) results are also consistent with Tollan and Heller's (2022) findings regarding the complement-adjunct asymmetry in pronoun resolution discussed in Section 1: Recall that, for pronouns in subject position (as was the case in Stockwell et al.'s experimental items), speakers of Niuean showed higher rates of coreference with a prior adjunct antecedent as compared with a complement antecedent, in simple declarative sentences with no movement/reconstruction

involved.

Furthermore, in Stockwell et al. (2022), acceptance rates of covaluation with a complement to a moved N were three times as high as a surface Condition C violation (their "Bad" item; 2.19 vs. 0.72). As Stockwell et al. note, their participants seem to have responded with preferences, with their ratings for each pair of interpretations adding up to approximately 8. Taking the scores out of 8, covaluation with a complement was accepted at rates comparable to what was found in other experiments: 2.19/8 = 27%. In Stockwell et al. (2021), the rate of acceptance was similarly high: 1.95/8 = 24% (in the Short condition; much higher in the Long condition). These rates are almost identical to what was found in Leddon and Lidz (2006) and Bruening and Al Khalaf (2019). As such, the results of Stockwell et al. (2021, 2022) are actually consistent with the other experimental findings, and our own. All of these experiments indicate that complements to N do not reconstruct, just like adjuncts. Only the head noun itself reconstructs.

We conclude that the body of empirical evidence thus far points towards a view in which neither complements nor adjuncts of Ns reconstruct. As we have shown, neither is reactivated in sentence comprehension, but head nouns are. This of course leaves open the question as to whether complements reconstruct in a manner which is not observable through either pronoun interpretation or reactivation, but, unless there is some other way to detect it, we do not see any way of knowing whether such reconstruction could exist.

3.2 The Representation of Movement Chains

Within theories of syntax that utilize movement, there are basically three approaches to representing movement. In the Government and Binding approach (e.g., Chomsky 1981), what was left behind in a gap site was a special element, a trace, which had properties distinct from those of the moved item. Chomsky (1993) proposed the second approach, the Copy Theory, which says that what occupies the gap site is a copy of the moved element. Finally, there is also a Multidominance approach to movement (e.g., Citko 2005). In the Multidominance approach, a phrase is dominated by two nodes. In wh-movement examples like ours, an object of a verb would simultaneously be

dominated by VP (it would be sister to V) and CP (sister to C-bar or its equivalent).

Our findings rule out the Multidominance approach. We can see no way in such an approach for the wh-filler to differ from what is present at the gap site. They are literally the same phrase, in this approach. If our interpretation of our findings is correct and only the head noun is represented at the gap site, then Multidominance approaches cannot be correct.

Our findings are compatible with the trace theory, provided that traces trigger reactivation of the head of the filler. Cross-modal lexical priming has always found reactivation of the head of a filler at the gap site (e.g., Swinney 1991, Hickok et al. 1992, Love and Swinney 1996), and (as far as we know) this has always been taken to be compatible with the trace theory. One could view a trace as essentially like a pronoun, and pronouns have also been found to reactivate the lexical content of their antecedents (Leiman 1982, Shillcock 1982, Nicol 1988).

As for the Copy Theory of movement, the original arguments given for it by Chomsky (1993) have not been borne out. As mentioned in the introduction, there are no convincing cases of reconstruction of anaphors inside moved NPs, since anaphors inside NPs are exempt from Binding Condition A. All experimental evidence indicates that there is no reconstruction for Binding Condition C, either.[5] Our findings now show that there is no reactivation of dependents of a moved N at the gap site. One might be tempted to take this as evidence against the Copy Theory. We do not think that it is, however, for several reasons.

First, there are proposals within the Copy Theory that are compatible with the facts. These proposals allow copies in a chain to differ from each other. For instance, Lebeaux (1988) and Chomsky (1993), among many others, have proposed that adjuncts can Late Merge countercyclically, merging with the head noun after it has moved. This would only need to be extended to

[5] A reviewer raises the following example:

(i) *? [How many pictures of Susan$_1$] did she$_1$ paint — in the pub?

We agree that coreference between *Susan* and *she* is much more difficult in this example than in others given in the literature. However, this is plausibly not due to Condition C. Reinhart and Reuland (1993) discuss phrases like *paint a picture of* and *perform an operation on*. They take these phrases to be a kind of predicate. The reviewer's example in (i) is a Condition B violation on this approach, since the (complex) predicate has two coindexed arguments but neither of them is a reflexive-marker. On this approach, (i) is not about Condition C at all, and may have nothing to do with reconstruction (depending on one's analysis).

complements of N (or Ns do not take complements, only adjuncts, as in Reuland 2011, Adger 2013, Grimm and McNally 2013). Another proposal comes from Bruening and Al Khalaf (2019), who propose that the derivation proceeds left-to-right, so all of the material in the filler is merged first in the moved position. At the gap site, copying is minimal, such that it copies only what is needed. This is only the head noun itself. A third idea is that there can be vehicle change (Fiengo and May 1994) in lower copies, with R-expressions being replaced by pronouns (e.g., Safir 1999, Sauerland 2003). However, Hunter and Yoshida (2016) argue that there cannot be vehicle change in movement, only in ellipsis, and Adger et al. (2017) argue that vehicle change cannot be the right explanation for the lack of Condition C reconstruction they found in their experiments. It is also not clear whether vehicle change is compatible with our results: As just noted, cross-modal lexical priming studies have found that pronouns activate the lexical content of their antecedents (Leiman 1982, Shillcock 1982, Nicol 1988). If so, then we would not expect R-expressions and any pronouns covalued with them to differ on measures of lexical reactivation. We therefore reject vehicle change as a possible explanation for our findings. However, since there are at least two analyses within the Copy Theory of movement that are compatible with our results, we do not think that our study should be taken as evidence against the Copy Theory of movement.

The second reason not to rule out the Copy Theory comes from predicate fronting. Complements of moved predicates (verbs, adjectives, prepositions), in contrast with complements of moved Ns, have been found to reconstruct for Binding Condition C (Leddon and Lidz 2006, Adger et al. 2017, Bruening and Al Khalaf 2019). If the gap position were just a trace, this would not be expected. One could suggest, as Huang (1993) did, that the moved predicate contains a representation of the subject of the predicate. On this analysis, Binding Condition C is violated internal to the moved predicate, not in the reconstructed position. However, this cannot account for the fronted PPs that Bruening and Al Khalaf (2019) studied. They found that an adjunct inside the fronted PP did not reconstruct, while the complement of the P did. If binding took place entirely in the fronted constituent, the adjunct should have given rise to a Binding Condition C effect. These findings require the Copy Theory of movement, along with less than a full copy in the gap position

(in particular, adjuncts are not represented in the gap position).

Third, anaphors and pronouns that undergo A-bar movement themselves can reconstruct, for instance in clefting:

(15) It was himself$_1$/*him$_1$ that the speaker$_1$ criticized most.

(16) a. I thought it was (only) himself$_1$/*him$_1$ that you said that that speaker$_1$ criticized.

b. I thought it was him$_1$ that he$_1$ said you criticized.

In the trace theory, the trace of A-bar movement is supposed to be an R-expression subject to Binding Condition C, regardless of what the moved NP is. The grammaticality of the anaphor in (15) and (16a) is then unexpected, as is the grammaticality of the pronoun in (16b). One could perhaps claim that the anaphor is being used as a logophor rather than as an anaphor, but this will not help to explain why the trace of the pronoun is not acting like an R-expression in (16b). In contrast, on the Copy Theory, the anaphor and the pronoun are the heads of the moved NP, and so there is a copy of them in the gap position. We then expect Binding Conditions A and B to apply so that the anaphor and the pronoun act as though they have not moved, which is exactly the case.

Given all of these considerations, we conclude that the Copy Theory is currently the best approach to representing movement chains. However, our data, and all the experimental data regarding Condition C, indicate that copies in gap positions are not complete copies. In particular, arguments and adjuncts of moved Ns are not represented in the gap site, only the head N is.

Appendix: Experimental Items

1. (Which word appeared last? question, relations)

   (a) The senators couldn't agree on which discussion question the important subcommittee on foreign relations should issue a statement about first.

   (b) The senators couldn't agree on which discussion of a question the important subcommittee on foreign relations should issue a statement about first.

(c) The senators couldn't agree on which discussion after a question the important subcommittee on foreign relations should issue a statement about first.

(d) The senators couldn't agree on a discussion question when the important subcommittee on foreign relations issued a statement about cooperation.

(e) The senators couldn't agree on a discussion of a question when the important subcommittee on foreign relations issued a statement about cooperation.

(f) The senators couldn't agree on a discussion after a question when the important subcommittee on foreign relations issued a statement about cooperation.

2. (Which word appeared last? state, hall)

(a) University officials were still not sure about which study hall the group of safety experts from the state government should investigate first.

(b) University officials were still not sure about which study of the hall the group of safety experts from the state government should investigate first.

(c) University officials were still not sure about which study in the hall the group of safety experts from the state government should investigate first.

(d) University officials were still not sure about the study hall when the group of safety experts from the state government showed up to investigate.

(e) University officials were still not sure about the study of the hall when the group of safety experts from the state government showed up to investigate.

(f) University officials were still not sure about the study in the hall when the group of safety experts from the state government showed up to investigate.

3. (Which word appeared last? time, sounds)

(a) Animal behavior researchers are trying to figure out which reaction time the sequence of high-frequency sounds should have led them to expect.

(b) Animal behavior researchers are trying to figure out which reaction to time the sequence of high-frequency sounds should have led them to expect.

(c) Animal behavior researchers are trying to figure out which reaction due to time the sequence of high-frequency sounds should have led them to expect.

(d) Animal behavior researchers are trying to figure out the reaction time after the sequence of high-frequency sounds should have led to an expectation.

(e) Animal behavior researchers are trying to figure out the reaction to time after the sequence of high-frequency sounds should have led to an expectation.

(f) Animal behavior researchers are trying to figure out the reaction due to time after the sequence of high-frequency sounds should have led to an expectation.

4. (Which word appeared last? device, table)

(a) The detective is trying to uncover which side table the cleverly constructed and deadly explosive device had been placed on.

(b) The detective is trying to uncover which side of the table the cleverly constructed and deadly explosive device had been placed on.

(c) The detective is trying to uncover which side away from the table the cleverly constructed and deadly explosive device had been placed on.

(d) The detective is trying to uncover the side table after the cleverly constructed and deadly explosive device went off nearby.

(e) The detective is trying to uncover the side of the table after the cleverly constructed and deadly explosive device went off nearby.

(f) The detective is trying to uncover the side away from table after the cleverly constructed and deadly explosive device went off nearby.

5. (Which word appeared last? office, warrant)

(a) The president of the firm needs to decide about which corner office the police force with a search warrant should be shown to first.

(b) The president of the firm needs to decide about which corner of the office the police force with a search warrant should be shown to first.

(c) The president of the firm needs to decide about which corner near the office the police force with a search warrant should be shown to first.

(d) The president of the firm needs to decide about that corner office before the police force with a search warrant shows up first.

(e) The president of the firm needs to decide about that corner of the office before the police force with a search warrant shows up first.

(f) The president of the firm needs to decide about that corner near the office before the police force with a search warrant shows up first.

6. (Which word appeared last? lawyer, writer)

(a) A reporter is looking into which biography writer a well-known and highly successful lawyer filed an injunction against yesterday.

(b) A reporter is looking into which biography of a writer a well-known and highly successful lawyer filed an injunction against yesterday.

(c) A reporter is looking into which biography from a writer a well-known and highly successful lawyer filed an injunction against yesterday.

(d) A reporter is looking into a biography writer after a well-known and highly successful lawyer threatened to file an injunction.

(e) A reporter is looking into a biography of a writer after a well-known and highly successful lawyer threatened to file an injunction.

(f) A reporter is looking into a biography from a writer after a well-known and highly successful lawyer threatened to file an injunction.

7. (Which word appeared last? squadron, fighters)

   (a) The general was stunned at which attack squadron the ragtag band of rebel fighters had managed to join.

   (b) The general was stunned at which attack on his squadron the ragtag band of rebel fighters had managed to join.

   (c) The general was stunned at which attack near his squadron the ragtag band of rebel fighters had managed to join.

   (d) The general was stunned at the attack squadron after the ragtag band of rebel fighters had managed to join their forces.

   (e) The general was stunned at the attack on his squadron after the ragtag band of rebel fighters had managed to join their forces.

   (f) The general was stunned at the attack near his squadron after the ragtag band of rebel fighters had managed to join their forces.

8. (Which word appeared last? brother, model)

   (a) Art historians have been unable to identify which portrait model the king of France's younger brother became hopelessly obsessed with.

   (b) Art historians have been unable to identify which portrait of a model the king of France's younger brother became hopelessly obsessed with.

   (c) Art historians have been unable to identify which portrait done without a model the king of France's younger brother became hopelessly obsessed with.

   (d) Art historians have been unable to identify the portrait model because the king of France's younger brother became hopelessly obsessed with secrecy.

   (e) Art historians have been unable to identify the portrait of a model because the king of France's younger brother became hopelessly obsessed with secrecy.

(f) Art historians have been unable to identify the portrait done without a model because the king of France's younger brother became hopelessly obsessed with secrecy.

9. (Which word appeared last? analyst, connections)

   (a) The government was conducting an inquiry into which report analyst the agency director with shady connections had tried to bury.

   (b) The government was conducting an inquiry into which report on an analyst the agency director with shady connections had tried to bury.

   (c) The government was conducting an inquiry into which report from an analyst the agency director with shady connections had tried to bury.

   (d) The government was conducting an inquiry into a report analyst after the agency director with shady connections had tried to bury evidence.

   (e) The government was conducting an inquiry into a report on an analyst after the agency director with shady connections had tried to bury evidence.

   (f) The government was conducting an inquiry into a report from an analyst after the agency director with shady connections had tried to bury evidence.

10. (Which word appeared last? students, boxes)

   (a) The art teacher needs to select which drawing boxes the advanced class of art students would get the most benefit from.

   (b) The art teacher needs to select which drawing of boxes the advanced class of art students would get the most benefit from.

   (c) The art teacher needs to select which drawing from those boxes the advanced class of art students would get the most benefit from.

   (d) The art teacher needs to select some drawing boxes before the advanced class of art students can get the most benefit from the lesson.

(e) The art teacher needs to select a drawing of boxes before the advanced class of art students can get the most benefit from the lesson.

(f) The art teacher needs to select a drawing from those boxes before the advanced class of art students can get the most benefit from the lesson.

11. (Which word appeared last? books, house)

(a) The art collector needs to decide about which sketch books appraisers from the high-end auction house should get access to first.

(b) The art collector needs to decide about which sketch of books appraisers from the high-end auction house should get access to first.

(c) The art collector needs to decide about which sketch with books appraisers from the high-end auction house should get access to first.

(d) The art collector needs to decide about the sketch books before appraisers from the high-end auction house come to access the collection.

(e) The art collector needs to decide about the sketch of books before appraisers from the high-end auction house come to access the collection.

(f) The art collector needs to decide about the sketch with books before appraisers from the high-end auction house come to access the collection.

12. (Which word appeared last? birth, tools)

(a) An art historian is writing about which painting tools a medieval monk of humble birth seems to have created.

(b) An art historian is writing about which painting of tools a medieval monk of humble birth seems to have created.

(c) An art historian is writing about which painting done without tools a medieval monk of humble birth seems to have created.

(d) An art historian is writing about painting tools since a medieval monk of humble birth seems to have created new techniques.

(e) An art historian is writing about a painting of tools since a medieval monk of humble birth seems to have created new techniques.

(f) An art historian is writing about a painting done without tools since a medieval monk of humble birth seems to have created new techniques.

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