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Reconstruction in *wh* movement: the view from lexical reactivation

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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; their complements and adjuncts do not.

Keywords: reconstruction; *wh* movement; lexical reactivation; interference

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 & Reuland 1993 argued that apparent instances of reconstruction for Binding Condition 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 & Sag 1992, Fox & Nissenbaum 2004).

(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, n. 1)

The point of disagreement is whether the pronoun *he* can be co-valued 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 co-valued with *Trump*, there is a violation of Binding Condition C. Binding Condition C forbids an R-expression like *Trump* from being co-valued 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):

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

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

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

(6) *Which investigation near Trump's house did he resent?*
(Based on Safir 1999: 589, n. 1)

On the other hand, Bianchi 1995, Lasnik 1998, Kuno 2004, and Henderson 2007 suggest that the contrast between (3) and (6) is not very strong and may not even exist. The authors give numerous examples where, according to them, co-valuation 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 co-valuation *is* possible. Leddon & Lidz 2006 found that adults permit co-valuation in examples like (3) 23% of the time (while children overwhelmingly prefer the co-valued interpretation). Adger et al. 2017 also found that adults accepted the co-valuation interpretation. Adger et al. also found an effect of linear distance, such that participants were more likely to permit co-valuation the greater the distance was between the fronted NP and the pronoun. Bruening & Al Khalaf 2019 found that native speakers chose the co-valuation 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 and 2022 claimed to find that participants do *not* permit co-valuation in examples like (3) but do in examples like (6).

Note that all of this research has looked only at the question of whether co-valuation 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 & Al Khalaf 2019, co-valuation 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 (Sheldon 1974, Chafe 1976, Ariel 1990, Grosz et al. 1995, Chambers & Smyth 1998, Almor 1999, Kehler 2000, Arnold 2001, 2010, 2013, and Rohde & Kehler 2014, among others). In (7), for example, 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 grammatical and/or thematic role with the pronoun (Sheldon 1974, Smyth 1992, Chambers & Smyth 1998, Kehler 2000, Frazier & Clifton 2006); and morphological parallelism, where a preference emerges for an antecedent that is case matched with the pronoun (Tollan & 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 & Heller 2022 found that a pronoun in subject position (just like *he* in the examples in (3–6)) triggered a preference for an antecedent in an adjunct position (i.e., an oblique-marked adjunct to an intransitive VP) over 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 & Heller's 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-co-valuation judgments, 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 & Heller—a matter that 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*, not of *Trump*.

2 Experiment: lexical reactivation

2.1 Overview

We designed a novel lexical-interference task, where participants first must read a sentence and then are presented with two words from that sentence. Their task is to identify which of the two words appeared *last*. 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 & 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* comes 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 used this idea to test reconstruction of complements and adjuncts to nouns. Unlike previous work on reconstruction, which has only compared complements of nouns to adjuncts, we used 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 with that of complements and that of complements with that of adjuncts 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 idea illustrated in (8) yields the paradigm in (10). Here, the word *question* appears before the word *relations*—thus, the correct answer to the question in (12) is *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? (*question*, *relations*)

The baseline items (BASE) have a structure similar to the corresponding WH items and involve mostly the same lexical items, but the first of the two words (here, *question*) is no longer 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 than in the BASE condition. We could (instead or in addition) find decreased accuracy in the responses to this condition. All researchers agree that the head N reconstructs, so we minimally expect reactivation in the HEAD condition. In contrast, everyone agrees that adjuncts 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)?

2.2 Method

We ran a forced-choice comprehension experiment, with a 2 × 3 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) and (11).

2.2.1 Materials

We constructed 12 sets of items like those in (10) and (11) (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 & 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 six lists, according to a Latin-square design. We coupled these with 12 filler items, six of which had an embedded *how* or *why* question, such as (13a), and six of which were declaratives, such as (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*)

2.2.2 Participants

208 participants recruited from Amazon's Mechanical Turk took part in the experiment in exchange for two US dollars (2 USD). 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).

2.2.3 Procedure

The experiment was run via PCIbex Farm (Zehr & Schwarz 2018). Participants were instructed to read each sentence. The sentence was presented in its entirety in 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 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 in advance 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.

2.3 Data analysis

Data from two participants was excluded because they did not self-identify as L1 English speakers, and data from a further eight 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 (0.09% 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 4,000 ms (an estimated mean by-word reading time below 200 ms; $n = 195$), and we also removed trials with long reading times of over one minute in total ($n = 14$).

We analyzed the remaining 2,167 trials by fitting three 2×3 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

[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.

conditions (Movement, two levels) and was sum coded as +1/2 for WH and –1/2 for BASE. The second manipulation, Position (three levels), was contrast coded using centered Helmert contrasts. The first coefficient, HEAD versus COMPLEMENT + ADJUNCT, compared the HEAD conditions (coefficient: +2/3) with the COMPLEMENT and ADJUNCT conditions, pooled (coefficient: –1/3 for each). The second coefficient, COMPLEMENT versus ADJUNCT, contrasted complements (coefficient: –1/2) with adjuncts (coefficient: +1/2): this contrast compares the COMPLEMENT and ADJUNCT conditions 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).

2.4 Results

We first analyzed 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 2 × 3 logistic-regression model revealed no significant main effects or interactions (all ps $>$ .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 reaction times 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 analyzed via a 2 × 3 mixed-effects linear regression following the procedure described above.

We found a main effect of Movement, where reaction times for WH conditions were slower overall than BASE conditions (4,136 ms vs. 4,012 ms; $\beta = -0.014$, $SE = 0.007$, $t = -2$, $p = .048$). There were no other significant main effects (both ps $> .6$). Most importantly, however, we find an interaction of Movement with HEAD versus

[2] Because our analysis of response accuracy yielded no significant effects, we included reaction times for all 2,167 trials in our analysis. As noted in Wilson & Dillon 2024, 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 reaction times in our analysis.

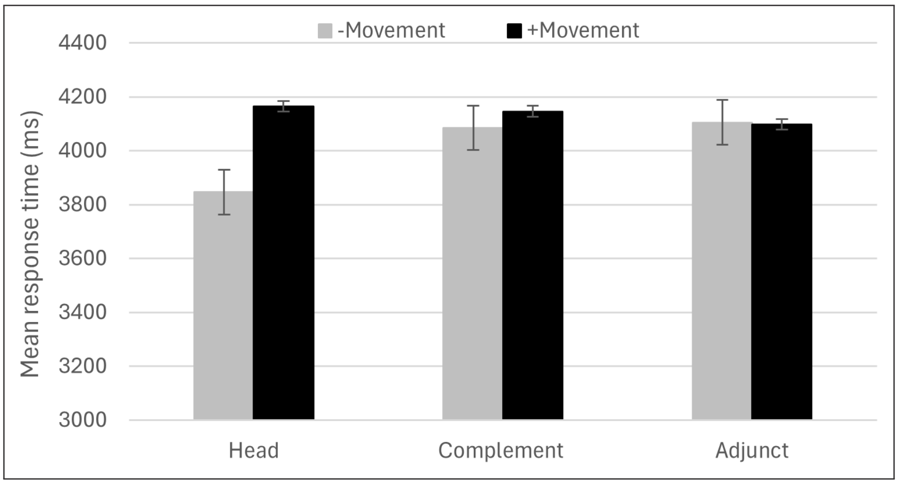

Figure 1: Mean response times for each level of Position according to Movement (+Movement WH in black bars; –Movement BASE in grey bars). Error bars indicate ±1 SE.

COMPLEMENT and ADJUNCT, pooled ($\beta = -0.035$, $SE = 0.015$, $t = -2.4$, $p = .019$), but critically no interaction of Movement with COMPLEMENT versus 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 Position (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 reaction times (4,164 ms vs. 3,846 ms; $\beta = -0.04$, $SE = 0.01$, $t = -3.1$, $p = .002$), but not for complements or adjuncts ($ps > .84$).[3]

2.5 Discussion

We find evidence that reaction time in 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

[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 4,135 ms) do not appear to reflect any sort of ceiling-level effect: Of our 12 filler items, four of them (i.e., one third) had response times *higher* than this threshold (from 4,660 ms to 5,340 ms).

Effect	*β*	*SE*	*t*	*p*
(Intercept)	3.56	0.02	224	<.0001
HEAD versus COMPLEMENT + ADJUNCT	–0.003	0.007	–0.4	.7
COMPLEMENT versus ADJUNCT	–0.004	0.009	–0.5	.61
Movement	**–0.01**	**0.007**	**–2**	**.048**
HEAD versus COMPLEMENT + ADJUNCT × Movement	**–0.04**	**0.02**	**–2.4**	**.019**
COMPLEMENT versus ADJUNCT × Movement	0.004	0.02	0.03	.98
a) Position = HEAD				
Movement	**–0.04**	**0.01**	**–3.1**	**.002**
b) Position = COMPLEMENT				
Movement	–0.0025	0.01	–0.2	.84
c) Position = ADJUNCT				
Movement	–0.002	0.01	–0.17	.87

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

effect. There is, however, a potential alternative explanation for this result. Given that the NPs in the HEAD conditions (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

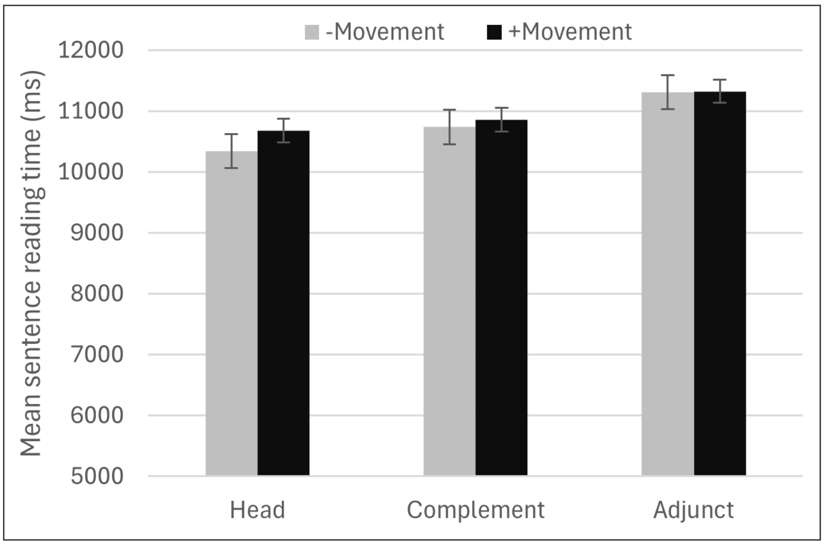

Figure 2: Mean sentence reading times by condition (+Movement WH in black bars; –Movement BASE in grey bars). Error bars indicate ±1 SE.

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 than in the COMPLEMENT and ADJUNCT conditions, pooled (10,510 ms vs. 10,798 ms/11,318 ms; $\beta = -0.026$, $SE = 0.007$, $t = -3.7$, $p = .0002$). Participants also took longer to read sentences in the COMPLEMENT conditions than in the ADJUNCT conditions, overall ($\beta = 0.025$, $SE = 0.008$, $t = 2.6$, $p = .008$). These differences in reading times are likely to reflect differences in the length of the sentences in the HEAD, COMPLEMENT, and ADJUNCT conditions: 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 versus 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

[4] We checked this by also calculating an estimated mean reading time by character for each critical trial, dividing the overall sentence time by the number of characters in each sentence (not including spaces). Here, the mean estimated by-character reading time was 95 ms, 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.

times for the COMPLEMENT and ADJUNCT conditions than for 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 the BASE–HEAD, BASE–COMPLEMENT, and BASE–ADJUNCT sentences.)

In sum, it appears that our critical interaction for response time (see figure 1) is unlikely to be due to participants spending more time reading the WH–COMPLEMENT and 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.

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 that appeared last in the previously presented sentence). As indicated statistically by a significant interaction of Position 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 here:

(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 in the introduction, there is currently a debate regarding whether complements inside moved NPs reconstruct for Binding Condition C. We have found that the complement of 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 has found that neither complements nor adjuncts to N trigger a Condition C effect. It is not consistent with Stockwell et al. 2021 and 2022, which 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. 2022's results are also consistent with Tollan & Heller 2022's findings regarding the complement–adjunct asymmetry in pronoun resolution discussed in the introduction: recall that, for pronouns in subject position (the same configuration used in Stockwell et al.'s experimental items), speakers of Niuean showed higher rates of co-reference with a prior adjunct antecedent than with a complement antecedent, in simple declarative sentences with no movement/reconstruction involved.

Furthermore, in Stockwell et al. 2022, acceptance rates for co-valuation with a complement to a moved N were three times as high as a surface Condition C violation (Stockwell et al.'s "Bad" item; 2.19 vs. 0.72). As the authors 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, co-valuation 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 & Lidz 2006 and Bruening & Al Khalaf 2019. As such, the results of Stockwell et al. 2021 and 2022 are actually consistent with the other experimental findings and our own. All of these experiments indicate that complements to N, just like adjuncts, do not reconstruct. 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 possibility that complements reconstruct in a manner that 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 & 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 in 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

[5] A reviewer raises the following example:

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

We agree that co-reference 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 & Reuland 1993 discusses phrases like *paint a picture of* and *perform an operation on*. Reinhart & Reuland 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 co-indexed 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).

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 counter-cyclically, merging with the head noun after it has moved. This would only need to be extended to complements of N (or else Ns do not take complements, only adjuncts, as in Reuland 2011, Adger 2013, Grimm & McNally 2013). Another proposal comes from Bruening & Al Khalaf 2019: 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 & May 1994) in lower copies, with R-expressions being replaced by pronouns (e.g., Safir 1999, Sauerland 2003). However, Hunter & Yoshida 2016 argues that there cannot be vehicle change in movement, only in ellipsis, and Adger et al. 2017 argues that vehicle change cannot be the right explanation for the lack of Condition C reconstruction the authors found in their experiments. It is also not clear whether vehicle change is compatible with our results. As noted above, 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 co-valued 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 & Lidz 2006, Adger et al. 2017, Bruening & 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 internally to the moved predicate, not in the reconstructed position. However, this cannot account for the fronted PPs that

Bruening & Al Khalaf 2019 studied. It was 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 would not help to explain why the trace of the pronoun does not act 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 other 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.

Supplementary material

A file containing the appendix can be downloaded at https://doi.org/10.16995/star.17373.s1.

Data-availability statement

The data that support the findings of this study are openly available at https://osf.io/9spq5/files/osfstorage.

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Competing interests

The authors declare that they have no competing interests.

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