

Processing adjunct control: Rapid use of structural information in reference resolution

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Anaphora resolution requires integration of pragmatic, syntactic, and conceptual sources of information [1, 2, 4, 5, 9]. We ask whether it matters to the timing of reference resolution if the surface signal to anaphora is an audible pronoun, like “he” in (a), or a non-finite participial verb, like “eating” in (b). These forms of anaphora differ in two ways. First, only in (a) is the signal to anaphora (‘he’) dedicated to reference to an individual. Second, while in (a) the pronoun in principle allows any salient male to be the eater, in (b) the sentence itself requires that Mickey is the eater, since “eating” is the predicate of a non-finite clause, which generally has its subject role filled anaphorically by the next highest subject. Because of these differences, one might expect the timing of the resolution of the anaphora in (b), often labeled “control” [3], to differ from the resolution of a pronoun [8]. We show in two visual-world eyetracking experiments that listeners are able to use structural information to rapidly resolve the anaphora in (b).

- (a) Mickey talked to Minnie [before he ate].
- (b) Mickey talked to Minnie [before ____ eating].

Experiment 1— Participants listened to auditory descriptions of images on the screen (see Table 1 and Figure 1). We manipulated which character the description focused on initially, as well as whether the signal of reference in an included temporal adjunct was a non-finite verb (labeled the ‘PRO’ condition) or a pronoun agreeing in gender with the subject or object of the main clause, in a 3×2 design. On average, the verbs were 160 ms longer in duration than the pronouns. Therefore, if both types of reference are resolved equally quickly after the relevant bottom-up input, reference in the PRO condition should be resolved no more than 160 ms later than pronominal reference.

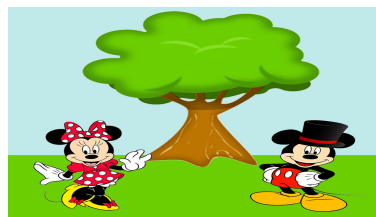


Figure 1: Sample visual stim.

Condition	Text
PRO	Look <u>there's</u> Mickey! Minnie was talking to <u>him</u> in front of a huge tree after <u>putting</u> on a nice new bow, and they seem to be having a good time.
subj-pron	<u>she</u> put on a nice new bow, and they seem to be having a good time.
obj-pron	<u>he</u> put on a nice new hat, and they seem to be having a good time.

Table 1: Sample auditory stimuli from Exps. 1 and 2 (critical word underlined)

Results were analyzed using cluster-based permutation [6] and growth curve analyses [7]. There was no meaningful effect of focus in the region of interest, suggesting that reference resolution was possible irrespective of information structure. Figure 2 gives the effect of reference type. Looks to the target character beginning at the onset of the underlined region were initially faster, with fewer looks to the competitor, in the PRO condition compared to the pronoun conditions ($p < 0.05$). Why would participants actually be faster (by 50-75 ms) to resolve the anaphora in the PRO condition when the bottom-up input appears to be delayed? One possibility is that our sentence contexts predicted control structures more than pronouns, as indicated by a separate cloze task ($n=60$) where participants continued the item preamble (up to ‘after’) with a non-finite verb 52% of the time. Another possibility is a strategy of assuming that any continuation other than ‘he’/‘she’ corresponded to a control structure.

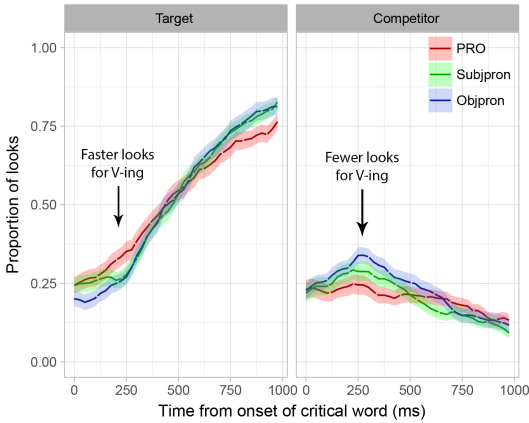


Figure 2: Experiment 1 results (n=30).

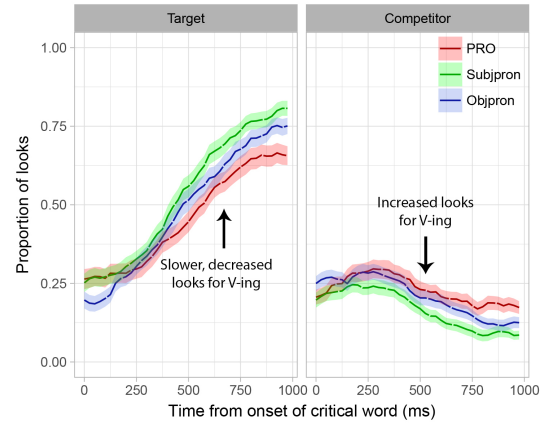


Figure 3: Experiment 2 results (n=30)

Experiment 2— Exp. 2 was designed to investigate why resolution of reference in the PRO condition in Exp. 1 appeared almost too fast. The stimuli in Exp. 2 were identical to those of Exp. 1, with the addition of fillers such as (c). These new fillers contained a non-pronominal subject in the adjunct, such that participants might need to listen longer to determine whether a non-pronoun onset corresponded to a control structure.

- (c) Look there's Donald! Minnie found him outside of Daisy's house after Daisy kicked him out for being rude.

Results (n=30) are given in Figure 3. Despite a continued potential subject bias, analyses revealed that looks to the target character had a shallower slope ($p < 0.001$) and were significantly lower ($p < 0.05$) in the PRO condition than the subject pronoun condition, suggesting slower reaction times. The PRO condition also saw significantly more looks to the competitor ($p < 0.01$). Resolution of the anaphora was estimated to be roughly 150 ms slower in the PRO condition than the subject pronoun condition, comparable to the difference in cue length.

Discussion— In Exp. 1, when listeners were able to assume that any non-pronoun input signaled a control structure, they were able to resolve reference faster than in pronoun conditions. In Exp. 2, when the bottom-up input was not disambiguated as quickly, reference took longer. Given that the non-finite verbs in the PRO conditions in these experiments were roughly 160 ms longer than the pronouns, it may have been the case that reference resolution took just as long in either case, once the full cue to anaphora was received. This suggests that listeners were able to resolve the anaphora as fast as feasibly possible given the bottom-up input, despite the relative complexity of the cue to anaphora.

References

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