

The search continues: Evidence of sustained antecedent search in picture NPs

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Introduction: Anaphoric elements such as *himself* start underspecified for their reference, but their meaning can be inferred through a connection with another NP, the *antecedent*. When an antecedent appears before an anaphor, this connection is established by a memory retrieval process that links the anaphor to an earlier noun in memory [1]. However, it is also possible for an anaphoric element to precede its antecedent, forming a *cataphoric* dependency. Resolving cataphoric dependencies requires maintaining the anaphor in memory until it can be associated with a later element in the sentence. Previous work suggests that there are strong pressures to resolve a reflexive anaphorically, and the parser will attempt to link a reflexive to an NP in memory even if such a link violates syntactic constraints [2]. In the present study, we investigate the processing of English reflexives within ‘picture NPs’ that are housed in wh-phrases such as (1). Both anaphoric (matrix subject) and cataphoric (embedded subject) coreference relations are possible. Previous work on the resolution of anaphors in such picture NPs has focused on how the material linearly preceding the reflexive impacts reading at the reflexive [2-4]. We instead focus on the processing of a potential cataphoric NP in three cases: when there is no potential antecedent prior to the reflexive, when there is a gender matching potential antecedent, and when there is a gender mismatching potential antecedent.

Experiment 1: We compare cases where a gender matching antecedent appears before the reflexive to cases where the only potential antecedent appears after the reflexive, i.e. late antecedent NP. In an L-Maze reading experiment, 47 participants read 24 items in a 2×2 design (Table 1). Reading times were residualized for word length and evaluated using linear mixed-effects models. We find a main effect such that the late NP is processed more slowly when there is a prior potential antecedent ($\beta = 98.39$, $p < 0.001$). We also find a significant Gender Mismatch Effect (GMME) such that late NPs which match the gender of the reflexive are processed more quickly than those that mismatch the reflexive ($\beta = -117.40$, $p < 0.001$) regardless of the presence of a preceding antecedent. This suggests the processing of reflexives does not end after an antecedent has been identified. Instead, the parser continues to evaluate potential cataphoric antecedents, though with some additional cost if an antecedent has been previously identified. Results visualized in Figure 1.

Experiment 2: There is a third possible configuration, where a potential antecedent before the reflexive mismatches the reflexive. In an L-Maze reading experiment, 48 participants read 24 items in a 2×2 design (Table 2), comparing an early match to an early mismatch. At the reflexive, we find a significant GMME such that reflexives that match the early NP are read more quickly than those that do not ($\beta = -59.98$, $p < 0.001$), reflecting coreference evaluation with the matrix subject, visualized in Figure 2. At the late NP, we observe an interaction such that a late NP is read faster when it matches both the reflexive and the early NP, but a late NP is read more slowly when it matches the reflexive but not the early NP ($\beta = -234.950$, $p < 0.001$), visualized in Figure 3. Thus, search for a cataphoric antecedent continues in both cases, but the processing of the late NP is impacted by the presence of an earlier mismatch.

Conclusion: Despite intense pressure to resolve reflexives anaphorically, the parser continues to evaluate potential cataphoric antecedents. This process of continued search incurs additional costs, likely linked to maintaining the reflexive and reanalyzing coreference relations. The unexpected gender match effect suggests resolving anaphoric mismatch is a complex process.

(1) Louis₁ noticed [which picture of himself_{1/2} at the castle]₃ Max₂ liked _₃ the best.

Table 1: Experiment 1 Design

Early NP	Late NP	Sentence
Match	Match	Louis noticed which picture of himself at the castle Max liked the best.
Match	Mismatch	Louis noticed which picture of himself at the castle Mae liked the best.
None	Match.	Which picture of himself at the castle did Max like the best?
None	Mismatch	Which picture of himself at the castle did Mae like the best?

Table 2: Experiment 2 Design

Early NP	Late NP	Sentence
Match	Match	Louis noticed which picture of himself at the castle Max liked the best.
Match	Mismatch	Louis noticed which picture of himself at the castle Mae liked the best.
Mismatch	Match.	Louis noticed which picture of herself at the castle Mae liked the best.
Mismatch	Mismatch	Louis noticed which picture of herself at the castle Max liked the best.

Figure 1: Experiment 1 Late NP

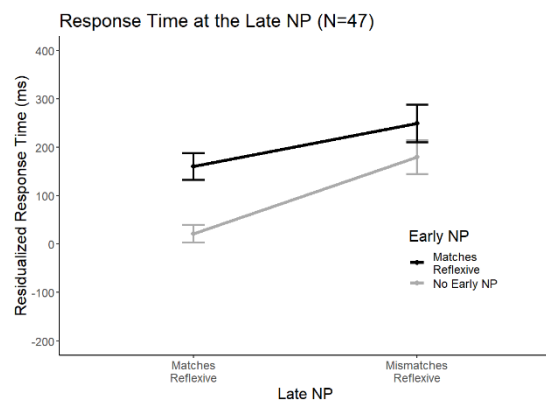


Figure 2: Experiment 2 Reflexive

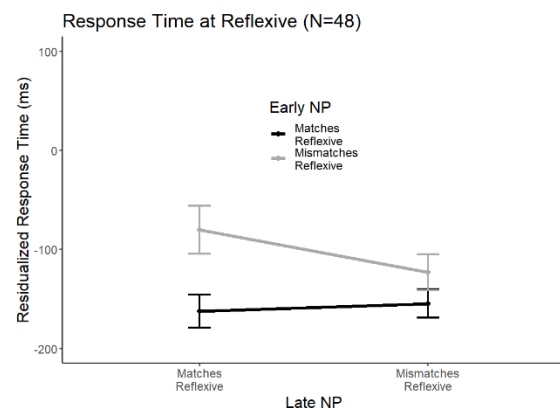
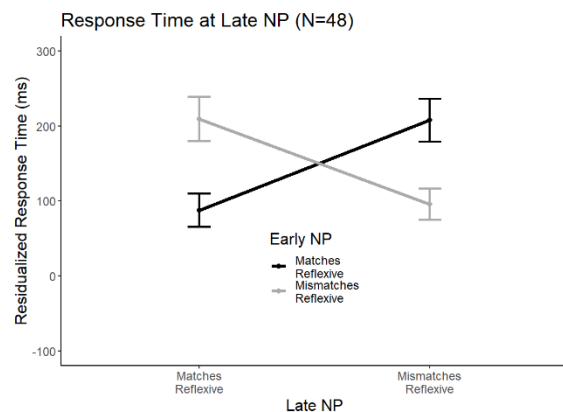


Figure 3: Experiment 2 Late NP



[1] Sturt (2013). Syntactic constraints on referential processing. *In Sentence processing*.
 [2] Omaki, Ovans, Yacovone, Dillon. (2019). Rebels without a clause. *JML*.
 [3] Cunnings & Sturt. (2014). Coargumenthood and the processing of reflexives. *JML*.
 [4] Kaiser, Runner, Sussman & Tanenhaus. (2009). Structural and semantic constraints on the resolution of pronouns and reflexives. *Cognition*.