



Agreement attraction during comprehension of grammatical sentences: ERP evidence from ellipsis



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ABSTRACT

Successful dependency resolution during language comprehension relies on accessing certain representations in memory, and *not* others. We recently reported event-related potential (ERP) evidence that syntactically unavailable, intervening attractor-nouns interfered during comprehension of Spanish noun-phrase ellipsis (the determiner *otra/otro*): grammatically correct determiners that mismatched the gender of attractor-nouns elicited a sustained negativity as also observed for incorrect determiners (Martin, Nieuwland, & Carreiras, 2012). The current study sought to extend this novel finding in sentences containing object-extracted relative clauses, where the antecedent may be less prominent. Whereas correct determiners that matched the gender of attractor-nouns now elicited an early anterior negativity as also observed for mismatching determiners, the previously reported interaction pattern was replicated in P600 responses to subsequent words. Our results suggest that structural and gender information is simultaneously taken into account, providing further evidence for retrieval interference during comprehension of grammatical sentences.

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1. Introduction

Understanding language often requires remembering what was previously said. In the narrowest sense of this ‘remembering’, we access or reactivate linguistic representations that we recently processed in order to form ongoing, coherent structures and integrate incoming information. In other words, we must link linguistic representations through time in a grammatical way, forming linguistic dependencies, and do so often in the face of processing other words or phrases within the dependency:

- (a) Marta se compró la camiseta y Miren cogió otra ____.
Marta bought the *t-shirt* and Miren took another ____.

To understand this basic Spanish sentence, the noun *t-shirt* (*camiseta*) must be interpreted upon encountering *another* (*otra*) to mean *another t-shirt*. Thus, forming the linguistic dependency between *another* and its antecedent *t-shirt* requires, at minimum, retrieving *t-shirt* from memory. However, at the onset of *another*,

there are presumably other representations in memory that may interfere with the retrieval and interpretation of *t-shirt*, a phenomenon known as *retrieval interference* (Anderson & Neely, 1996; Martin, Nieuwland, & Carreiras, 2012; McElree, 2006; McElree, Foraker, & Dyer, 2003). The often-minimal information that must be used to access the relevant information in memory, or *retrieval cues*, becomes vital to interpretation. What information counts as a retrieval cue in a sentence context is still largely unknown, but an increasing body of evidence implicates syntactic and morphosyntactic, as well as semantic information as giving rise to retrieval interference during dependency formation (Martin et al., 2012; McElree et al., 2003; Van Dyke & McElree, 2011). Because presence of these types of representations in memory appears to create processing difficulty or interference, these findings have been taken as evidence that these types of information may be used to elicit target representations from memory (i.e., function as retrieval cues). Although different levels of linguistic structure have not been extensively tested, it stands to reason that an efficient system would use all relevant types of linguistic representations available at retrieval. Discovering which particular representations control or contribute most to processing of different dependency types may yet inform psycholinguistic and neurobiological theories about the computational architecture of the human language faculty. One example paradigm that has recently informed this

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debate is the existence of agreement attraction phenomena during comprehension of subject–verb dependencies such as *the key to the cabinets was* (e.g., Bock & Miller, 1991; Cunnings & Felser, 2013; Dillon, Mishler, Sloggett, & Phillips, 2013; Nicol, Forster, & Veres, 1997; Pearlmutter, Garnsey, & Bock, 1999; Staub, 2009; Tanner, Nicol, Herschensohn, & Osterhout, 2012; Wagers, Lau, & Phillips, 2009). We relate the current findings to existing literature on agreement attraction in comprehension, which generally deals with linguistic phenomena other than ellipsis and (purely) grammatical gender, in our Discussion section.

1.1. Language specific cues

In languages like Spanish, words in certain syntactic relationships with one another must agree in grammatical gender. Thus, recovery of the antecedent is likely to be guided by gender cues at retrieval that point to the relevant memory representations (e.g., feminine gender-marking on *otra* that agrees with the gender of the antecedent *camiseta*). However, such a system also entails the possibility that these cues are inadvertently mapped onto other, perhaps more recent or similar, entries in memory:

- (b) Marta se compró la camiseta que iba bien con la falda y Miren cogió otra _.
Marta bought the t-shirt that went well with the skirt and Miren took another _.

Here, the same linguistic dependency as in (a) needs to be resolved: *another* must be understood as *another t-shirt*, not as *another skirt*. In English, and in Spanish, this occurs because *skirt* is structurally unavailable¹ as antecedent; structural position alone inherently prevents *skirt* to be the antecedent for *another*. However, in Spanish the structurally unavailable intervening noun (i.e., the local attractor *falda*) also has a grammatical gender that could correspond, as in this example, or not, with *otra/another*. Here the determiner *otra* can only mean *otra camiseta*, and introduces a new discourse referent of the same type as *camiseta*. Importantly, *otra* does not refer to the same instance of *camiseta* (Eguren, 2010), and is therefore not a pronoun or anaphor (which, except for cataphoric pronouns, refer back to a given referent). Eguren (2010) describes *otra* in this instance as a determiner that allows nominal ellipsis (see Martin et al., 2012 for discussion). This determiner must agree with the gender of the elided noun and morphological gender information could thus serve in resolving the dependency (Badecker & Straub, 2002; Sturt, 2003).

1.2. Cue-based retrieval interference during processing of ellipsis

The linguistic construction *otro/a* in (a/b) is representative of the type of challenge language users routinely face, establishing basic sentential relations despite a missing argument noun phrase, or interpreting “elided” information. Importantly, ellipsis antecedents bear no special marking that might engage special memory strategies. Behavioral studies of ellipsis processing suggest that interpreting more material between the antecedent and the ellipsis site decreases the likelihood of successful retrieval, and therefore of successful interpretation (Martin & McElree, 2008, 2009, 2011), consistent with an account of retrieval during sentence comprehension where match between cue and target shape processing (Martin et al., 2012; McElree et al., 2003; Nairne, 2002; Van Dyke & McElree, 2011). For the purpose of testing the role of cue-based retrieval interference during language comprehension,

Martin, Nieuwland, & Carreiras (2012; henceforth ‘MNC’) constructed an ellipsis paradigm in Spanish based on (b), but resolved with a determiner that does not agree with the antecedent, ‘otro’ in place of ‘otra’ in (b), creating an ungrammatical condition:

- (c) *Marta se compró la camiseta que iba bien con el vestido y Miren cogió otro _.
 *Marta bought the t-shirt that went well with the dress and Miren took another _.

MNC found a sustained negativity to incorrect agreement (c) compared to correct agreement (b), and this negativity was modulated by the gender of a local attractor noun (either mismatching attractor *vestido* or matching attractor *falda*). Grammatically correct determiners following a locally mismatching noun (*camiseta...vestido...otra*) elicited a reliably more negative-going ERP response than following a locally matching attractor noun (*camiseta...falda...otra*). This pattern suggests that an illicit attractor that does not match the retrieval cue impacts or disrupts processing, even in a fully grammatical sentence. The interaction suggests that the attractor gender affects antecedent retrieval, but that similarity or feature overlap alone does not drive the effect. The sustained negativity elicited by incorrect determiners was surprising because previous literature has consistently reported that local agreement violations (e.g., *el camiseta*: Barber & Carreiras, 2005; see also Hanulíková, Van Alphen, Van Goch, & Weber, 2012) elicit P600 effects, a broadly distributed positive shift that is most commonly associated with syntactic computations (e.g., Hagoort, Brown, & Osterhout, 1999). P600 effects are not only reliably elicited by syntactic violations (e.g., Barber & Carreiras, 2005; Osterhout & Mobley, 1995), but also by constructions that are well-formed but whose syntactic properties do not fit the analysis currently being pursued or that was previously expected (e.g., Kaan & Swaab, 2003; Osterhout & Holcomb, 1992; Van Berkum, Brown, & Hagoort, 1999). Notably, pronouns with unexpected or incorrect gender-marking also evoke P600 effects (e.g., Nieuwland & Van Berkum, 2006; Osterhout & Mobley, 1995; Silva-Pereyra, Gutierrez-Sigut, & Carreiras, 2012; Van Berkum, Koornneef, Otten, & Nieuwland, 2007). The lack of a P600 effect reported by MNC, however, can be directly linked to previous ERP findings on the resolution of sentence- and discourse-level referential dependencies. Sustained negativities (the Nref; Van Berkum et al., 1999; see Nieuwland & Van Berkum, 2008a, for review) have been associated with referentially problematic expressions, e.g., referential ambiguity arising from having multiple suitable candidate antecedents in the discourse model. In light of these results, although an elided constituent is not a pro-form or a trace (Eguren, 2010), grammatically incorrect determiners during ellipsis might be problematic for referential reasons (i.e., insufficient to retrieve a unique antecedent). Such is also assumed in memory-based processing models of anaphor resolution (e.g., Gerrig & O’Brien, 2005): antecedents that have sufficient features in common with anaphors are automatically elicited from memory, whereas antecedents that do not require additional retrieval processes. Sustained negativities associated with referentially problematic expressions might be an electrophysiological correlate of these additional retrieval processes (Nieuwland & Van Berkum, 2008a,b; although see Burkhardt, 2006, for different ERP results on introducing referents through anaphoric bridging inferences; see also Kaan, Dallas, & Barkley, 2007), possibly related to sustained frontal shifts that are evoked by linguistically complex structures (King & Kutas, 1995).

Given the novelty of the attractor-modulated sustained negativity found by MNC, the current study attempts to expand this finding to sentences with different syntactic relationships between retrieval cues, antecedents and attractors. We used the same

¹ Because *dress* is in a relative clause, and nouns cannot be bound outside of the relative clause they occur in (Chomsky, 1981).

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