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The time-course of feature interference in agreement comprehension: Multiple mechanisms and asymmetrical attraction

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ABSTRACT

Attraction interference in language comprehension and production may be as a result of common or different processes. In the present paper, we investigate attraction interference during language comprehension, focusing on the contexts in which interference arises and the time-course of these effects. Using evidence from event-related brain potentials (ERPs) and sentence judgment times, we show that agreement attraction in comprehension is best explained as morphosyntactic interference during memory retrieval. This stands in contrast to attraction as involving the representation of the subject NP's root-node number feature, which is a strong contributor to attraction in production. We thus argue that the cognitive antecedents of agreement attraction in comprehension are non-identical with those of attraction in production, and moreover, that attraction in comprehension is primarily a consequence of similarity-based interference in cue-based memory retrieval processes. We suggest that mechanisms responsible for attraction during language comprehension are a subset of those involved in language production.

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Introduction

Successful language processing requires the integration of grammatical information across linguistic units within a sentence. One grammatical dependency that must be computed in many languages is subject–verb agreement. Agreement phenomena are of particular interest because they present some interesting paradoxes for language processing. For example, while native English speakers tend to ignore agreement information in determining participant roles in off-line language comprehension tasks (MacWhinney, Bates, & Kliegl, 1984), violations of subject–verb agreement readily trigger processing difficulty during real-time comprehension (Kreiner, Garrod, & Sturt, 2013; Osterhout & Mobley, 1995; Pearlmutter, Garnsey, & Bock, 1999). Moreover, although English agreement morphology is relatively impoverished and the rules of English agreement are relatively simple, both producers and perceivers are known to make errors in verb number marking. These errors are especially likely to occur in contexts where a sentence's subject noun phrase (NP) contains two nouns that mismatch in number features (e.g., *The key to the cabinets...*). In sentence production tasks, it has been shown that such cases lead to an increased number of errors in number marking on the verb (*The key to the cabinets are...*), where the verb erroneously agrees with the "local"

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(linearly closer) plural noun (e.g., *cabinets*; henceforth 'attractor' noun) rather than singular head noun of the subject NP (e.g., *key*).

Importantly, these errors, known as 'attraction' errors, can reliably be elicited in laboratory experiments focused on language production (Bock & Cutting, 1992; Bock & Eberhard, 1993; Bock & Miller, 1991; Eberhard, 1999; Gillespie & Pearlmutter, 2011; Hartsuiker, Schriefers, Bock, & Kikstra, 2003; Solomon & Pearlmutter, 2004; Staub, 2009, 2010; Vigliocco, Butterworth, & Garrett, 1996; Vigliocco, Butterworth, & Semenza, 1995; Vigliocco & Nicol, 1998), and later research found that plural attractors can interfere with the normal processing of verb agreement during language comprehension as well (e.g., Kaan, 2002; Nicol, Forster, & Veres, 1997; Pearlmutter, 2000; Pearlmutter et al., 1999; Thornton & MacDonald, 2003; Wagers, Lau, & Phillips, 2009). Since the earlier production-based studies focused on contexts in which errors arise, many comprehension studies also included error conditions (i.e., subject–verb agreement violations), because contrasting the processing of agreement errors in comprehension and production can yield useful information about the mechanisms supporting grammatical dependencies like agreement across the two task types. Studying the conditions under which attraction errors and attraction-based interference arise can inform us not only about the types of linguistic cues that enter into the computation of agreement dependencies, but also the nature of the mechanisms responsible for these computations, grammatical encoding, and the processing of long distance dependencies more generally.

Although agreement in comprehension has received considerably less attention than in production, the findings of attraction effects in both modalities suggests that similar information sources are used when establishing agreement dependencies. An important question is whether the general susceptibility to attraction in comprehension and production also points to shared cognitive, computational, or linguistic mechanisms used to establish agreement dependencies when speaking and reading, or whether attraction interference has different sources depending on the modality. The prevailing assumption in much psycholinguistic work is that the presence of attraction in both modalities indicates that agreement has largely overlapping cognitive or linguistic bases in production and comprehension (Badecker & Kuminiak, 2007; Hartsuiker, 2006; Nicol et al., 1997; Pearlmutter et al., 1999; Severens, Jansma, & Hartsuiker, 2008; Thornton & MacDonald, 2003; Wagers et al., 2009; see also Kreiner et al., 2013), though there remains debate about the exact nature of the processes giving rise to interference effects.

A unified, modality-neutral account is an attractive possibility, not least because it appeals to notions of parsimony: similar patterns of interference in comprehension and production should be explained by assuming a common cognitive mechanism or linguistic representation. This meshes with recent studies that find similarities in syntactic processing in comprehension and production, using behavioral methods (e.g., syntactic priming, Bock, Dell, Chang, & Onishi, 2007), and neuroimaging (e.g., fMRI, Segaert, Menenti, Weber, Petersson, & Hagoort, 2012).

Furthermore, all of this aligns with recent models of language processing which propose an extremely tight link between language comprehension and production mechanisms (e.g., Gennari & MacDonald, 2009; MacDonald, 2013; Pickering & Garrod, 2013).

Despite this, there are fundamental differences in comprehension and production, and the two necessarily use a set of processing systems that are at least partly distinct. Production begins with abstract conceptual messages; comprehension begins with sensory input (auditory, visual, or even tactile). It is therefore possible that a differing set of underlying processes may give rise to only superficially similar profiles of interference. The goal of the present paper is to investigate attraction interference during language comprehension, and in the process, gain a more detailed understanding of the relationship between the processes underlying the formation of agreement dependencies in language production and comprehension. We focus in particular on the contexts in which interference arises, as well as the time course of the interference effects. In doing so, we use a methodology which has not been extensively used to study agreement attraction, namely event-related brain potentials (ERPs).

Mechanisms of agreement and interference symmetries

Despite early findings of similar patterns of interference in production and comprehension, more recent findings on attraction suggest that the two domains may differ with regard to the contexts in which attraction interference arises. This suggests that the assumption of a shared mechanism needs further scrutiny. In particular, these conflicting findings point to a larger debate about the cause of attraction itself.

One family of theories holds that attraction arises because the mental representation of the number feature of the subject NP is faulty or ambiguous (e.g., Eberhard, Cutting, & Bock, 2005; Franck, Vigliocco, & Nicol, 2002; Nicol et al., 1997; Staub, 2009; Staub, 2010; Vigliocco & Nicol, 1998). On this account, attraction arises because the abstract plural feature of an attractor noun can erroneously spread throughout the syntactic representation of the subject NP, either through upwards feature percolation (Franck et al., 2002) or via spreading activation through a hierarchically structured syntactic tree (Eberhard et al., 2005; Hartsuiker, Antón-Méndez, & van Zee, 2001). It should be noted that these theories were initially developed to account for production data; however, these ideas have also been applied to comprehension (e.g., Nicol et al., 1997; Pearlmutter et al., 1999), and we do so here. Others have argued that attraction effects can have a representational locus, but from slightly different perspectives. For example, some argue that attraction arises from stages of a syntactic derivation, as conceptualized within Minimalist syntactic theory (e.g., Franck, Lassi, Frauenfelder, & Rizzi, 2006), or from statistically-based representations formed through language experience (e.g., Haskell, Thornton, & MacDonald, 2010).

A second class of approaches argues that attraction effects arise because the processing mechanisms