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Processes underpinning gender and number disagreement in Dutch: An ERP study

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ABSTRACT

In the current experiment, participants read word-by-word sentences containing gender (adjective-noun) and number (article-noun) disagreement in Dutch while EEG was recorded. Number and gender disagreement were expected to elicit different responses due to several reasons. Firstly, gender is a lexical feature whose value (e.g., masculine or feminine) is stored in the lexicon, whereas number value is assigned depending on conceptual knowledge (numerosity). Also, Dutch marks number but not gender on the noun. Finally, due to the morphological nature of number, number disagreement provides more repair options than gender disagreement, thereby increasing the processing load. Both gender and number disagreement elicited a P600, but no LAN. The P600 effect was larger for number than gender disagreement in the late P600 stage. Since the observed effect was in the late P600 stage, we suggest that the most salient difference between the two types of disagreement lies in the increased repair complexity for number disagreement compared to gender disagreement.

1. Introduction

1.1. Number and gender as nominal features

Both gender and number are grammatical properties of nouns. In linguistic theory, they are often grouped together with person and labelled 'phi-features' (Adger & Harbour, 2008). All phi-features are always further specified with an appropriate value for their category, such as singular and plural for number. Quite often, this feature value also needs to be marked on an element different than the noun. For example, the article in Dutch has to have identical feature values as the noun it modifies. Therefore, if the noun is plural, the article has the plural form. However, the numerosity of the noun is obvious from the noun itself and feature reduplication onto the article is redundant in this case, as it does not bring any new information (Corbett, 2003). The process of establishing a relationship between two elements by transferring feature values from one to another is called agreement (e.g., Pesetsky & Torrego, 2007). The focus of this study is to investigate how number and gender features are decoded and processed in article/adjective-noun disagreement.

Agreement is, thus, a syntactic process whereby a relationship is established between elements at the syntactic level. But before agreement happens, the phi-features on the noun have to be valued. The way number and gender features receive and instantiate their value is where these features diverge most. In Dutch, gender is pervasively a lexical feature (e.g., Van Berkum, 1996). In terms of

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production theories, the gender value is stored as a separate node at the lemma level (e.g., Levelt, Roelofs, & Meyer, 1999). Therefore, the gender value is part of the noun's lexical syntax, and it is invariable. In some languages (e.g., Spanish and Italian), the gender feature is also overtly marked on the noun as a gender morpheme. Overt gender marking in Dutch is possible only when the noun contains a derivational suffix that is always associated with a specific gender value (e.g., nouns with the diminutive suffix *-(t)je* are always neuter). Number, however, is valued differently. Firstly, the speaker needs to assess the numerosity of the chosen concept: that is, whether there is only one or more than one entity. Once the value is determined, it is realized as a number morpheme on the noun (e.g., Roelofs, 1997). In case of Dutch, only plural nouns are morphologically marked (*-en*, *-s*).

The current study investigates the difference in the processing of the number and the gender feature embedded in agreement context in Dutch. This was achieved by carrying out an online event-related potentials (ERP) experiment based on a 'violation paradigm' (e.g., Osterhout, McLaughlin, Kim, Greenwald, & Inoue, 2004) comparing instances of grammatical gender and number agreement to gender and number disagreement/mismatch (determiner-noun). The goal of the study was two-fold. Firstly, we tried to find out whether the parser is sensitive to the inherent differences between gender and number features (i.e., lexical vs. conceptual; presence/absence of morphological marking). Secondly, since the experiment is based on a violation paradigm, we strived to show that structural repair processes are different for gender and number disagreement. More precisely, the number feature allows for more variation in its parameter settings at the level of a single noun (e.g., singular, -inflection; plural, +inflection), thereby increasing the complexity of repair processes which play an important role in ERP measures.

1.2. Previous ERP research on agreement

Previous studies on ERPs and sentence processing have mostly reported the presence of three language-related components: N400, left anterior negativity (LAN), and P600 (Coulson, King, & Kutas, 1998; Friederici, 1995; Hagoort, Brown, & Groothusen, 1993; Kutas & Hillyard, 1980; Osterhout & Holcomb, 1992). These components are usually elicited through violation paradigms consisting of two sets of identical sentences, differing minimally at a single point. The first set comprises meaningful grammatical sentences (baseline) against which identical sentences containing a grammatical or semantic violation are compared. In case of a semantic violation, the expected response is the N400. This component is construed as a marker of semantic and discourse integration difficulties (Friederici, 2002; Kutas & Federmeier, 2011; Kutas & Hillyard, 1980).

The LAN and P600 are usually described as markers of syntactic processing (Friederici, 2002), which makes them expected components in agreement studies. Indeed, a large number of studies on agreement reported a biphasic response to agreement mismatch in the form of the LAN followed by the P600 (Barber & Carreiras, 2005; Barber, Salillas, & Carreiras, 2004; Gunter, Friederici, & Schriefers, 2000; Molinaro, Vespignani, & Job, 2008). As the name says, the left anterior negativity is a negative deflection peaking between 300 and 500 ms. It is usually left lateralized with anterior distribution (but see Osterhout et al., 2004). As to its function, it is characterized as being sensitive to morphosyntactic errors (e.g., Friederici, 2002; Molinaro, Barber, & Carreiras, 2011). The LAN is usually followed by a positive deflection peaking at 600 ms (P600). Some authors make a distinction between the early and late P600 (e.g., Hagoort & Brown, 2000). The early P600 lasts from 500 ms to 700 ms post-stimulus onset and has a broad distribution, whereas the subsequent late P600 is the strongest in the parietal regions. In addition to different topography, the two stages are stipulated to be somewhat functionally different. The early stage reflects integration difficulty, which is followed by reanalysis and repair in the late stage.

Based on the previous study, the most reliable agreement processing marker seems to be the P600. It is almost unanimously reported, which is not the case with the LAN (e.g., Aleman Bañón, Fiorentino, & Gabriele, 2012; Nevins, Dillon, Malhotra, & Phillips, 2007). As an illustration, several studies on Italian and Spanish gender and/or number agreement reported the LAN followed by the P600 (e.g., Caffarra & Barber, 2015; Caffarra, Siyanova-Chanturia, Pesciarelli, Vespignani, & Cacciari, 2015; Dowens, Vergara, Barber, & Carreiras, 2010; Molinaro et al., 2008; O'Rourke & Van Petten, 2011). However, studies on determiner-noun agreement in Dutch failed to report either LAN or the N400 (Loerts, Stowe, & Schmid, 2013; Meulman, Stowe, Sprenger, Bresser, & Schmid, 2014). Hagoort and Brown (1999) proposed that the LAN can only be elicited by a morphologically overt violation, such as number agreement. This explains the absence of the LAN in gender violations in Dutch in which gender is a lexical feature. However, it still does not explain the lack of the LAN effect in number violations. Moreover, this explanation goes against the findings from Italian (Caffarra et al., 2015) and Spanish (Caffarra, Barber, Molinaro, & Carreiras, 2017) in which LAN was obtained for both transparent and opaque nouns, demonstrating that overt morphology may not be crucial for eliciting the LAN.

Similarly, two studies on Spanish determiner-noun gender agreement found conflicting results regarding the LAN. Barber and Carreiras (2005) reported the LAN followed by the P600, whereas Wicha, Moreno, and Kutas (2004) only found the P600. The volatility of the LAN in terms of its seemingly random distribution across studies has not been explained yet, even though several accounts have been offered.

In addition to the functional explanation by Hagoort and Brown (1999), Molinaro, Barber, Caffarra, and Carreiras (2014) indicated that methodological and technical factors could play a role regarding the LAN, such as the choice of the reference electrode. Osterhout (1997), Tanner (2015), and Tanner and Van Hell (2014) suggested that the presence of the LAN might be due to individual variations among participants (see also Pakulak & Neville, 2010), as well as to the averaging nature in obtaining ERP components.

1.3. Gender and number agreement in Spanish

Both number and gender are nominal phi-features. As such, they are often believed to affect processing mechanisms in the same way, to the extent that some studies lumped sentences with number and gender violations together as one syntactic condition (e.g.,