

# The Effects of Grammatical Gender on Reference Processing in German: an ERP Study

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Grammatically masculine forms can refer to men and women, but may favour male-specific interpretations. Using a match-mismatch paradigm, the present event-related potential (ERP) study assessed how masculine grammatical gender in role nouns affects referent processing in German. Twenty participants read sentences in which a stereotypically neutral role noun (grammatically masculine or feminine) introduced a group of people. A sentence continuation specified the group as consisting in part of *men* or *women*, meaning continuations were either congruent (masculine–*men*, feminine–*women*) or incongruent (masculine–*women*, feminine–*men*) to the grammatical gender of the role noun. Incongruent continuations were expected to result in an N400-P600 complex. Between 300 and 500 ms, no N400-like effect was observed. Following masculine role nouns, all continuations were processed similarly ( $p = .891$ ). Following feminine role nouns, incongruent continuations elicited more positive responses than congruent ones ( $p = .045$ ). Between 500 and 800 ms, a P600-like effect was observed. For both masculine and feminine role nouns, incongruent continuations resulted in more positive responses than congruent ones ( $p = .039$ ). The results are discussed in terms of a two-stage model: initially, the incongruency between the masculine and *women* continuations goes unnoticed, yet leads to processing difficulties later on, implying a male-specific interpretation.

*Keywords:* grammatical gender, reference processing, EEG, P600, N400

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Gender is a social category we encounter on a daily basis, with gender equality having become an important socio-political issue. Cues to gender are present in language in many ways. For example, we find words describing gendered referents (e.g., *father* or *woman*). Language can also carry stereotype information, which is strongly linked to conceptual knowledge (e.g., *electrician* or *nurse*, associated with males and females, respectively). Additionally, grammatical gender may map onto social categories of male and female gender. Often, we find these mappings in so-called role nouns, which describe social importance or occupation, and constitute an important way of denoting human referents. Indeed, grammatical gender in role nouns has been considered increasingly relevant to the equality debate. It has been suggested that masculine grammatical gender in role nouns favours male-specific interpretations, yet the masculine is regularly used to generically talk about male and female referents. This raises the question of whether the masculine is adequate in representing society in a gender-neutral way. To assess this issue, the present study investigated how masculine grammatical gender affects our understanding of differently gendered referents.

### Behavioural research on gender cues

As a linguistic category, gender has been described to be “almost universally present in language [...]” (Irmen, Holt, & Weisbrod, 2010, p. 133). Indeed, the gender of a human referent can be indicated linguistically via diverse means. While lexical semantics (e.g., *woman*) cue gender explicitly, role nouns (e.g., *musician*) often only imply referent gender. Take the example of the role noun *musician(s)*. In English, the noun is not grammatically gendered in the singular or plural. Only via the use of pronouns, and only in the singular can the gender of the *musician* be revealed as she or he. In contrast, in many grammatically gendered languages, the same role noun is morpho-syntactically marked for gender. It seems, then, that role nouns are realised differently across languages, depending on the grammatical system.

Behavioural research across languages has investigated how role nouns are understood. In the absence of grammatical gender, referent gender is cued by stereotypicality (Gygax, Gabriel, Sarrasin, Oakhill, & Garnham, 2008; Sato, Gygax, & Gabriel, 2013). For example, in English, the noun *musicians* implies male referents (Misersky et al., 2014). In gendered languages, such

as German, grammatical gender indicates referent gender, since specific forms are used to describe females and males. While feminine role nouns (e.g., *Musikerinnen*<sub>feminine</sub> [fem.]) cue specifically for females, the masculine (e.g., *Musiker*<sub>masculine</sub> [masc.]) can be used for males, but it can be used as a generic too. As such, *Musiker*<sub>masc.</sub> can be used for a group of men or a mixed-gender group consisting of both men and women. In short: the masculine may yield specific as well as generic interpretations.

Behavioural research has revealed using a specific form such as *Musiker*<sub>masc.</sub> for a mixed-gender group (i.e., including both males and females) results in an ambiguity in interpretation. For example, Gygax et al. (2008) assessed the gender interpretation of role nouns by comparing English, which has natural gender, to French and German, both of which have grammatically masculine and feminine gender categories. Participants were presented with a stereotypically male or female role noun (in the masculine for French and German) in one sentence, and with an anaphoric noun (*men* or *women*) in a second. With a Yes or No response, participants had to indicate whether the sentence containing the anaphor was a sensible continuation of the sentence with the role noun. In English, participants’ responses and response times were linked to the stereotypicality of the role noun. There was no such effect of stereotypicality for French and German. Instead, in both these languages *men* continuations received more Yes responses (i.e., continuation is sensible) compared to *women* continuations. This was further reflected in the response times: participants were faster to judge *men* continuations as sensible compared to *women* continuations. Thus, despite being generically intended, the masculine was interpreted as specific. Recent studies have found similar effects in primary school children (Vervecken, Gygax, Gabriel, Guillod, & Hannover, 2015; Vervecken & Hannover, 2015). Presenting role nouns in the masculine or a gender-neutral form in German and Dutch, grammatical form was found to affect ratings of job status, difficulty, and accessibility. Specifically, the children reported lower self-efficacy –that is, whether they thought they could succeed in a job– when presented with the masculine. These results highlight the societal relevance of grammatical gender cues.

In sum, this research suggests grammatical gender to be highly relevant in guiding our understanding of human referents, which may even override stereotype information (Gygax et al., 2008; Irmen & Roßberg, 2004). In particular, grammatically masculine forms

seem to lead to male-specific interpretations, despite their use as a generic for all genders.

## ERP research on gender cues

Electroencephalography (EEG), in particular event-related-potentials (ERPs), has been used to assess the effects of gender cues on comprehension during online processing. ERP studies on gender cues regularly find N400 and P600 effects. A negative deflection around 300 to 500 ms after stimulus presentation, the N400 is generally linked to lexical-semantic processing (Kutas & Federmeier, 2011). The P600 is sensitive to syntactic mismatch and integration difficulties (Osterhout, McLaughlin, & Bersick, 1997b), and is characterised by a positive deflection around 500 to 800 ms after stimulus presentation.

To a large extent, ERP research on the effects of grammatical gender has studied the processing of non-human referents, such as object nouns. Recent work investigated the processing of gender-to-ending consistency in Italian (Caffarra, Siyanova-Chanturia, Pesciarelli, Vespignani, & Cacciari, 2015). The materials consisted of sentences containing determiner-noun pairs, which either matched in gender (*il<sub>masc.</sub> cucchiaino<sub>masc.</sub>* [the spoon]) or did not (*la<sub>fem.</sub> cucchiaino<sub>masc.</sub>* [the spoon]). Gender mismatches resulted in processing difficulties reflected by a P600 effect. Similar results were obtained with noun-adjective gender mismatches (e.g., *faro<sub>masc.</sub> -alta<sub>fem.</sub>* [lighthouse-high]) in Spanish sentences (Barber & Carreiras, 2005). Interestingly, the authors found the same mismatches presented as word-pairs outside of sentences elicited an N400 effect. According to Barber and Carreiras (2005), the N400 component can be driven by conceptual, lexical or morphological feature integration depending on task and stimuli. The authors thus concluded the N400 for the word-pairs reflected simple feature integration. By contrast, full sentences required more complex syntactic structure building, leading to the P600.

ERP research on human referent processing has predominantly focused on stereotype information embedded in role nouns. White, Crites, Taylor, and Corral (2009) used a match-mismatch paradigm and found word-pairs, which mismatched in stereotypicality (e.g., *secretary-aggressive*) elicited a larger N400 effect than matching word-pairs (e.g., *secretary-caring*). Research by Osterhout, Bersick, and McLaughlin (1997a) assessed the processing of reflexive pronouns (*himself/herself*) following a role noun in English. Pronouns either did or did not match an antecedent role noun's gender definition

(e.g., *bachelor*) or stereotype (e.g., *doctor*). The results revealed a P600 effect for gender mismatches. Interestingly, the amplitude of the P600 varied for stereotypical compared to definitional nouns. Mismatches between reflexives and definitional role nouns were considered more anomalous as they leave little room for interpretation, thus leading to larger P600 amplitude. Interestingly, an N400 was also found for the last word of each sentence for the definition-violating reflexives. The authors explain that in the stereotype-violating sentences, an acceptable interpretation had been derived. For the definition-violating sentences, this was not possible, leading to the N400. Testing German speakers, Irmen et al. (2010) investigated how stereotypicality of role nouns affects the processing of a subsequent referent. They presented their participants with sentences consisting of a stereotypically male or female role noun (e.g., *computer scientist*, stereotypically male), and a co-referential continuation, which was either neutral (e.g., *these people*), matching (e.g., *these men*) or mismatching (e.g., *these women*) with regards to gender. An N400 effect across all continuations following a stereotypically male role was observed, suggesting participants may have anticipated a mismatch. A later P600 effect shows a clear interaction between the stereotypicality of the role noun and the continuation, and was taken as the integration of the two nouns. Irmen et al. (2010) linked this to a two-stage model of reference resolution (Garrod & Terras, 2000): initial linking (bonding) relies on lexical-semantic information, whereas resolution takes place once additional information has been taken into account.

In sum, two ERP components are most regularly observed in the research on gender cues: the N400 and P600. Roughly speaking, the N400 reflects lexical-semantic processes, whereas the P600 is associated with systematic syntactic processing. Additionally, an N400-P600 complex has been described (e.g., Irmen et al., 2010), which might be especially relevant to the processing of role nouns. Both conceptual and syntactic information are relevant to successfully building co-reference (Schmitt, Lamers, & Münte, 2002), and this might be especially true for languages where semantics are increasingly subject to syntactic constraints as a result of grammatical gender. In German, for example, the semantic and grammatical gender of words describing human referents (e.g., *Frauen<sub>fem.</sub>* [women]) tend to agree (Irmen et al., 2010). This means lexical-semantic and syntactic processing difficulties may co-occur during the processing of grammatical gender cues for human referents. In line with previous interpretations of

the two ERP components, initial reference might be established by the bonding of conceptual and/or morphological features (N400), with a systematic analysis of grammatical gender taking place later on (P600).

**The present study**

Behavioural research shows how the grammatical gender of role nouns can affect understanding of human referents. Following a feminine form, only female referents are pragmatically and grammatically acceptable. By contrast, it is pragmatically acceptable to use a masculine form for male and female referents. Grammatically, however, only male referents are an acceptable match for a masculine role noun. The masculine has thus been suggested to lead to male-specific interpretations (Gygax et al., 2008), at least when explicit decision-making is required. ERPs provide the ideal measure to assess referent processing as separate from decision-making. Thus far, ERP research on grammatical gender has predominantly studied processing of nonhuman referents (e.g., Caffarra et al., 2015). In the case of human referent processing, ERP studies using role nouns have focused on stereotype processing (e.g., White et al., 2009). Motivated by Gygax et al.’s (2008) findings, the present study investigated how masculine grammatical gender affects the processing of differently gendered human referents. Specifically, the study aimed to assess whether the masculine is understood as gender-neutral (i.e., encompassing both females and males) or as specific to males. Focusing on the N400 and P600, which relate to

semantic and syntactic processing respectively, allowed for a comprehensive investigation of this question.

Grammatical gender may override stereotype information in decision-making, but the two are considered to interact during processing (Gygax et al., 2008; Irmen et al., 2010). In a match-mismatch paradigm, the present study thus used stereotypically neutral roles to systematically focus solely on the effects of grammatical gender. The experimental sentences introduced a group of people via a role noun (manipulated as grammatically masculine or feminine, e.g., *Studenten<sub>masc.</sub>* or *Studentinnen<sub>fem.</sub>*), and a sentence continuation specified the group as consisting in part, yet not exclusively, of men (*Männer<sub>masc.</sub>*) or women (*Frauen<sub>fem.</sub>*). This meant role noun and continuation either matched (masculine–*men*; feminine–*women*) or mismatched (masculine–*women*; feminine–*men*) in grammatical gender. Table 1 gives an example of the sentence stimuli.

Both the N400 and P600 have been observed in ERP studies on role nouns, and both conceptual and syntactic processes have been considered important for reference building. Thus, in this study, both components resulting from grammatical gender incongruencies between role nouns and continuations were expected. The analyses specifically focused on ERPs following the onset of the continuations (*men*, *women*) to assess how these are integrated with the preceding role noun. In line with the main research question, the following findings were hypothesised:

Firstly, it was anticipated that a role noun in the masculine would favour a male-specific interpretation of the referent. As a result, masculine role nouns

**Table 1.**

Example of the sentence stimuli and conditions.

Grammatical gender	Continuation	
Masculine	congruent ( <i>men</i> )	Die <b>Studenten<sub>masc.</sub></b> gingen zur Mensa, weil manche der <b>Männer</b> Hunger hatten. [The <b>students</b> went to the canteen, because some of the <b>men</b> were hungry.]
	incongruent ( <i>women</i> )	Die <b>Studenten<sub>masc.</sub></b> gingen zur Mensa, weil manche der <b>Frauen</b> Hunger hatten. [The <b>students</b> went to the canteen, because some of the <b>women</b> were hungry.]
Feminine	congruent ( <i>women</i> )	Die <b>Studentinnen<sub>fem.</sub></b> gingen zur Mensa, weil manche der <b>Frauen</b> Hunger hatten. [The <b>students</b> went to the canteen, because some of the <b>women</b> were hungry.]
	incongruent ( <i>men</i> )	Die <b>Studentinnen<sub>fem.</sub></b> gingen zur Mensa, weil manche der <b>Männer</b> Hunger hatten. [The <b>students</b> went to the canteen, because some of the <b>men</b> were hungry.]



followed by *women* continuations were hypothesised to lead to processing difficulties. In particular, both an N400 and a P600 effect were expected to reflect these difficulties, with incongruencies leading to a relatively more negative amplitude of the N400, and a relatively more positive amplitude of the P600.

Secondly, the masculine is used as a default for both male and female referents, whereas the feminine is only used for female referents. Theoretically, this allows for a more flexible gender interpretation following masculine role nouns. Processing difficulties (as reflected by the N400 and P600) were thus expected to be reduced for the masculine (masculine–*women*), compared to the feminine role nouns (feminine–*men*).

Gygax and Gabriel (2008) suggest using materials with both feminine and masculine forms may lead participants to consider them in direct contrast. This may amplify the interpretation of the masculine as specific to males, since the feminine is always specific to females. However, the motivation for including the feminine in this study was twofold. Firstly, since role nouns in the feminine always denote female referents, a pairing with male referents would be highly incongruent. The high specificity of the feminine would establish a benchmark of incongruency between role noun and continuation. This would allow for a more comprehensive interpretation of the results concerning continuations after a masculine form, which has a flexible use for all genders. Secondly, we often encounter both forms in a variety of contexts. As such, including both forms in this study provided an appropriate representation of a real-life situation.

## Methods

### Participants

Twenty native speakers of German (13 female, age range 19 – 29 years,  $M = 22.3$ ,  $SD = 2.68$ ) recruited from Radboud University's SONA system participated in this study. Participants provided written informed consent, and received course credit or payment for their participation. All had normal or corrected to normal vision and were right-handed. Four participants were excluded from further analysis; two due to a low number of trials after pre-processing, and another two due to accuracy on the content questions (described below) that was at or below chance. The study was approved by the local ethical committee (Commissie Mensgebonden Onderzoek, Regio Arnhem-Nijmegen).

## Materials and design

A total of 156 role nouns were selected from a recent norming study (Misersky et al., 2014) on the basis of their stereotypicality rating. Role nouns rated as stereotypically neutral ( $M = .47$ ,  $SD = .08$ , ranging between 1 = stereotypically female and 0 = stereotypically male) were included in the materials. Using these role nouns at the beginning of the sentence, coordinate clauses were created inspired by previous research (Gygax et al., 2008; Irmen et al., 2010). The sentence-initial role noun introduced a group of people, with the role nouns grammatical gender manipulated as masculine (e.g., *Studenten*<sub>masc.</sub>) or feminine (e.g., *Studentinnen*<sub>fem.</sub>). Later in the sentence, this group was specified as being partially consisting of men (*Männer*<sub>masc.</sub>) or women (*Frauen*<sub>fem.</sub>). Inspired by previous research (Gygax et al., 2008), pseudo-randomised quantifiers were selected to highlight the group was not exclusively made up of men or women; *einige* (a few/some), *mehrere* (several), *manche* (some), *einzelne* (single ones) or *viele* (many); refer to Table 1 for an example. In addition, 80 filler items were created, half of which followed a similar format, and half of which were structurally different, resulting in a total of 236 experimental sentences. Sentences were pseudo-randomised for presentation.

## Procedure

Participants were seated in a dimly illuminated sound-attenuating testing booth. They were instructed to attentively read the sentences, since they would receive content questions throughout the experiment. These instructions were both explained by the experimenter, and presented visually on the testing PC. Since eye movements distort the EEG recording, participants were also asked to only blink between sentences and during breaks. Participants were able to remain in contact with the experimenter via microphone. All interactions and instructions were in German.

Sentences were presented using Presentation software (Neurobehavioral Systems, www.neurobs.com). Each sentence was presented in a word-by-word serial visual presentation mode at the centre of a 24-inch PC monitor. The background was a dark grey with the words presented in white letters (Helvetica, font size 26). The beginning of each sentence was preceded by a fixation cross (+). Each word was flashed for 380 ms with an inter-

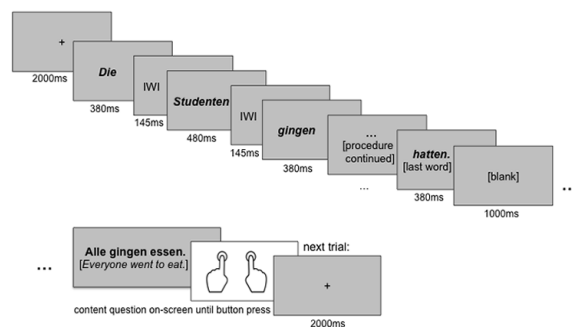
word-interval (IWI) of 145 ms. The second and fourth word of each sentence were flashed slightly longer, for 480 ms, due to word length. Sentence-final words were followed by a full stop, then a 1000 ms blank. Every ten sentences, a content question would appear on-screen, requiring a self-paced Yes or No response via button press with the left or right index finger, respectively. The question related to the activity carried out in the sentence; and there was no repetition of the role noun. The inter-trial-interval (ITI) was 2000 ms during which the fixation cross re-appeared. First, participants received nine practice sentences, after which remaining uncertainties about the task could be resolved. The experiment was split into four blocks of 59 trials each. There were self-paced pauses between blocks where a drink of water was offered to the participants. Figure 1 gives an example of the procedure.

## EEG set-up and apparatus

Continuous EEG was recorded from 32 active electrodes (10-20 system) attached to an elastic cap (actiCAP), with a BrainAmp DC amplifier (Brain Products, Gilching, Germany). The signal was sampled at 500 Hz. One electrode in the cap provided an active ground. Electrooculogram (EOG) was recorded from electrodes above and below the eye, and at the outer canthi of the eyes. Electrode impedances were kept below 20 k $\Omega$ .

The data was pre-processed using the FieldTrip toolbox for EEG/MEG-analysis (www.fieldtriptoolbox.org; Oostenveld, Fries, Maris, & Schoffelen, 2011) in MATLAB. For each continuation noun, segments were chosen in the range from 200 ms before to 1000 ms after word onset. Offline-filtering included a low-pass filter at 35 Hz and a high-pass filter at 0.1 Hz. The

Example sentence: Die **Studenten**<sub>masculine</sub> gingen zur Mensa, weil manche **der Männer** Hunger hatten.  
[The students went to the canteen, because some of the men were hungry.]



**Fig. 1.** Example of the word-by-word stimulus presentation followed by a content question.

data were then inspected visually, and trials showing electrode jumps and/or drifting were removed in preparation for an independent component analysis (ICA). ICA was performed to remove any remaining EOG and/or electrocardiogram (ECG) artefacts from the data. All channels were then referenced via the average of the signal of both mastoids (Luck, 2005). A baseline correction was applied in which the signal was normalised relative to a 200 ms stimulus preceding window. Trials containing signal exceeding  $\pm 75 \mu\text{V}$  were removed, and mean ERP amplitudes for the time windows of interest were calculated. The datasets of two subjects were excluded from further analysis, since less than 29 trials per condition ( $< 25$  percent) remained after pre-processing. The average amount of kept trials per condition for the included subjects was 34.65 (88.85%, ranging from an average of 34.43 to 34.75 trials across all conditions).

## Analysis

In line with existing work (Irmen et al., 2010; Osterhout et al., 1997a), mean ERP amplitudes were statistically analysed in two main time windows after the onset of the continuation noun; 300 to 500 ms for the N400, and 500 to 800 ms for the P600, respectively. The mean ERP amplitudes were analysed in SPSS. As in Irmen et al. (2010), nine electrodes in anterior, central and posterior positions of the left and right hemisphere and the midline were used for the statistical analyses (F3/z/4, C3/z/4, P3/z/4).

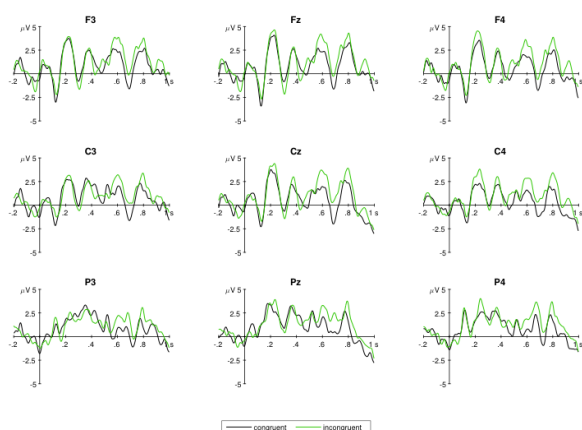
## Results

### Responses to content questions

The participants were accurate in correctly answering the content questions ( $M_{\text{present correct}} = 99.18$ ,  $SD = 3.26$ ), meaning they understood the task and were attentively reading the sentences throughout the experiment.

### Event-related potentials

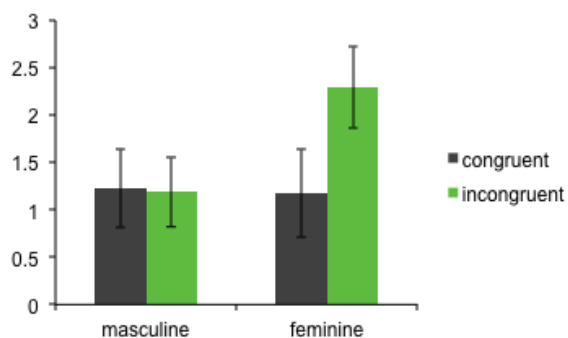
Following Irmen et al. (2010), the mean amplitudes of the ERPs for the time windows of interest were subjected to repeated-measures analyses of variance (ANOVA). The factors submitted to each ANOVA included Anteriority (three levels: anterior, central, posterior), Laterality (three levels: left, midline, right), Grammatical Gender of the role noun (two levels:



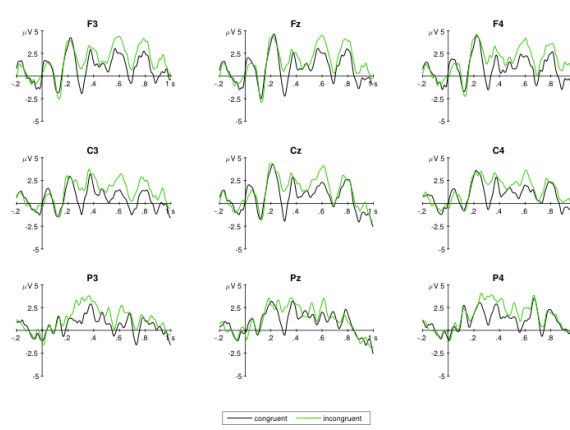
**Fig. 2.** ERPs for Continuations following a role noun with masculine grammatical gender.

masculine, feminine, see Table 1), and Continuation (two levels: congruent, incongruent, see Table 1). An alpha level of .05 was used for all statistical tests. Note that the effects for Grammatical Gender, Continuation, and the interaction between them are of prime relevance with regards to assessing the effects of grammatical gender on referent processing. Figures 2 and 3 represent the grand average ERPs for the nine electrodes separated by Grammatical Gender.

*300 to 500 ms time window.* The ANOVA revealed an interaction between Grammatical Gender and Continuation,  $F(1, 15) = 5.82, p = .029, \eta^2 = .28$ . Follow-up analyses were carried out for each Grammatical Gender separately (Fig. 4). For role nouns with masculine Grammatical Gender, there was no significant difference between congruent ( $M = 1.23 \mu V, SEM = .42$ ) and incongruent ( $M = 1.18 \mu V, SEM = .36$ ) continuations,  $F(1, 15) = .02, p = .891, \eta^2 = .001$ . For role nouns



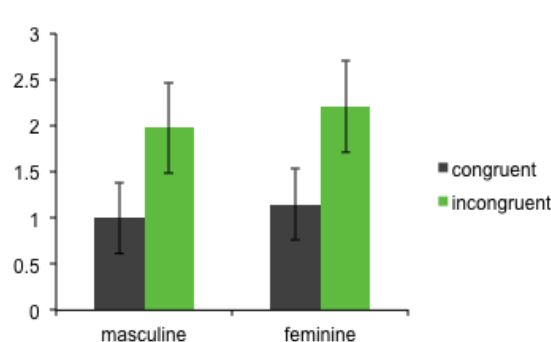
**Fig. 4.** Mean amplitudes in the 300–500 ms time window as a factor of Grammatical Gender (masculine vs. feminine) and Continuation (men vs. women).



**Fig. 3.** ERPs for Continuations following a role noun with feminine grammatical gender.

with feminine grammatical gender, however, responses to congruent Continuations differed significantly from those to incongruent ones,  $F(1, 15) = 4.78, p = .045, \eta^2 = .24$ . Incongruent Continuations elicited more positive responses ( $M = 2.29 \mu V, SEM = .44$ ) compared to congruent Continuations ( $M = 1.18 \mu V, SEM = .47$ ). There were no main effects of Grammatical Gender or Continuation, nor of Anteriority or Laterality.

*500 to 800 ms time window.* The ANOVA showed a main effect of Continuation,  $F(1, 15) = 5.13, p = .039, \eta^2 = .25$ . Regardless of the Grammatical Gender of the role noun, incongruent Continuations elicited significantly more positive responses ( $M = 2.09 \mu V, SEM = .46$ ), compared to congruent Continuations ( $M = 1.07 \mu V, SEM = .32$ , see Fig. 5). In this time window, there were no main effects of Anteriority or Laterality, nor any interactions between any of the factors.



**Fig. 5.** Mean amplitudes in the 500–800 ms time window as a factor of Grammatical Gender (masculine vs. feminine) and Continuation (men vs. women).

## Discussion

The present study assessed how grammatical gender affects referent processing. More specifically, the study focused on how grammatically masculine forms affect the processing of differently gendered referents. In line with previous research, masculine role nouns followed by *women* continuations were expected to lead to processing difficulties reflected by a complex of N400 (300 to 500 ms) and P600 (500 to 800 ms). Furthermore, effects of incongruency were expected to be reduced for continuations following a grammatically masculine role noun (masculine–*women*) compared to a grammatically feminine role noun (feminine–*men*).

In the 300 to 500 ms time window, an interaction between grammatical gender and continuation was found. Put differently, how the continuation was processed depended on the preceding grammatical gender. When participants read a role noun in the masculine, they processed both congruent and incongruent continuations similarly. By contrast, when they read a role noun in the feminine, the continuations were processed differently. Interestingly, the incongruent continuations elicited more positive responses compared to the congruent ones. This was unexpected, since for the N400, incongruencies tend to elicit relatively more negative responses compared to congruencies. Siyanova-Chanturia, Pesciarelli and Cacciari (2012) have looked into the processing of pronouns (*lei*[she]/*lui*[he]) following stereotypically (e.g., *insegnante*<sub>masc./fem</sub> [teacher]), and grammatically gendered (e.g., *pensionato*<sub>masc.</sub> [pensioner]) role nouns in Italian. For female participants, they observed positive responses to incongruencies between grammatically gendered roles and pronouns, and interpreted this effect as P300-like. The P300 has been linked to stimuli evaluation (Kutas & Hillyard, 1980a; Kutas & Hillyard, 1980b), and is sensitive to this evaluation being task-relevant (Holcomb, 1988). In line with this, Siyanova-Chanturia et al. (2012) attribute their finding to participants having made decisions on the word-pairs during the experiment. Unlike Siyanova-Chanturia et al. (2012), the present study used sentence stimuli. Additionally, participants did not need to explicitly evaluate the continuations, yet answering content questions may have increased the likelihood of participants evaluating the words more closely. While this opens up the possibility for a P300-like effect, additional exploration is needed to sufficiently examine this unexpected effect.

In the 500 to 800 ms time window, a relatively

more positive response to incongruent compared to congruent continuations was observed, regardless of the grammatical gender of the role noun preceding it. This result reflects a P600-like effect, meaning participants encountered processing difficulties upon reading *women* when preceded by a grammatically masculine role noun, and upon reading *men* when preceded by a grammatically feminine role noun.

In line with Irmen et al. (2010), the results can be linked to Garrod & Terras' (2000) two-stage reference processing model. During an initial bonding stage, the Continuation is linked to the role noun by an automatic process. Note that complete congruency required the grammatical gender of the role noun to match both the grammatical and lexical-semantic gender of the continuation. Despite the unexpected positive ERP amplitude of the incongruent continuations following a feminine role noun, it was clear bonding was different for the congruent compared to the incongruent continuations. This could be due to the feminine form being highly specific, effectively constraining processing early on. For role nouns in the masculine, however, all continuations were processed similarly. The absence of differential processing in this initial stage could be a result of the masculine form being pragmatically used to describe mixed-gender groups. Only in the later time window, during the reference resolution stage, incongruent continuations lead to processing difficulties with no difference between the two grammatical genders.

To sum up, the observed pattern of effects suggests the grammatical gender of the role noun guided the processing of the continuation. Firstly, a role noun in the feminine leads to differential processing for *men* and *women* continuations early on. Secondly, the mismatch between *women* continuations following a masculine goes unnoticed during initial processing. Thirdly, and importantly, this same mismatch leads to difficulties later on. Linking back to the research question, the results suggest people struggled integrating female referents (*women*) with the grammatically masculine form during late systematic processing. Thus, the grammatically masculine form seems to create a bias towards males, despite being used to encompass females and males. This finding implies the masculine form to be inadequate in representing the whole of society. A grammatical form that is truly gender-neutral and/or encompasses males and females specifically could be key to reducing the effects observed in behavioural research and in this study. A follow-up including such grammatically gender-neutral forms can assess the possibilities of reducing the bias encountered.



## Conclusion

The present study has shown that difficulties during referent processing are subject to grammatical constraints. In line with the behavioural research in this field, the data indicate grammatical gender to be an important cue to the understanding of human referents. This has relevant implications for the regular use of the masculine to talk about mixed-gender groups. Since its interpretation favours male referents, future research should aim to assess which grammatical forms can most effectively reduce the processing difficulties observed in this study.

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