Neural correlates of the implicit processing of grammatical and stereotypical gender violations: A masked and unmasked priming study

Published Version:
Neural correlates of the implicit processing of grammatical and stereotypical gender violations: A masked and unmasked priming study / Pesciarelli F.; Scorolli C.; Cacciari C.. - In: BIOLOGICAL PSYCHOLOGY. - ISSN 0301-0511. - ELETTRONICO. - 146:(2019), pp. 107714.1-107714.9. [10.1016/j.biopsycho.2019.06.002]

This version is available at: https://hdl.handle.net/11585/698227 since: 2019-09-07

Published:

DOI: http://doi.org/10.1016/j.biopsycho.2019.06.002

(Article begins on next page)

Neural correlates of the implicit processing of grammatical and stereotypical gender violations: A masked and unmasked priming study

Pesciarelli*+, F., Scorolli°, C., & Cacciari*+, C.

* *Department of Biomedical, Metabolic and Neural Sciences; + Center for Neuroscience and Neurotechnology, University of Modena and Reggio Emilia, Modena, ITALY*

° *Department of Philosophy and Communication Studies, University of Bologna, Bologna, Italy*

Correspondence to:

Francesca Pesciarelli

Department of Biomedical, Metabolic and Neural Sciences

Via Campi 287

41100 Modena (Italy)

phone: +39.059.2055340

fax: +39.059.2055363

e-mail: francesca.pesciarelli@unimore.it

Abstract

The aim of this study was to explore the neural correlates of the automatic activation of gender stereotypes by using the masked and unmasked priming technique. Event-related potentials (ERPs) were recorded while participants were presented with an Italian third-person singular pronoun (*lui* or *lei*) that were preceded by either a grammatically-marked (e.g., *passeggera*$_{FEM}$, *pensionato*$_{MASC}$) or stereotypically-associated (e.g., *insegnante*$_{FEM}$, *conducente*$_{MASC}$) role noun. Participants were required to judge the grammatical gender of the personal pronoun ignoring the preceding word. This word was presented in a masked or unmasked way. The results revealed slower reaction times and larger N400, in both the masked and unmasked conditions, when the pronouns were preceded by gender-incongruent than gender-congruent grammatical and stereotypical primes. A P300 effect also emerged in both masked and unmasked conditions for the grammatical gender mismatch between the antecedent and the pronoun. These results provide evidence that gender stereotypes can strongly influence our behavior even under unconscious conditions.

Keywords: gender stereotypes, event-related potentials, masked priming, N400, P300

1. Introduction

Gender-role stereotypes influence how we experience and construe information concerning people and how we judge individual skills and attitudes. Although social stereotypes serve the same function of other types of category-based knowledge, they represent a distinct form of knowledge stored in long-term memory (Contreras et al., 2011). The prevailing view is that activation of stereotypical knowledge in language processing occurs automatically, i.e., outside of people's awareness, it is immediate and difficult to inhibit (Banaji & Hardin, 1996; Carreiras et al., 1996; Ellemers, 2018; Fabre et al., 2015, 2016; Garnham et al., 2002; Molinaro et al., 2016; Oakhill et al., 2005; Osterhout et al., 1997; Proverbio et al., 2018, 2017; Siyanova-Chanturia et al., 2012, 2015). However, the studies arguing in favor of an automatic activation of gender stereotypes (typically triggered by the presentation of occupational role nouns, e.g., *engineer*, *teacher,* isolated or embedded in sentences) presented words/sentences above threshold as unmasked stimuli. The aim of this event-related potentials (ERPs) study was to investigate the activation of gender stereotypes using a technique designed to unveil the unconscious processing of a stimulus, the masked priming technique. Perception without awareness has been strongly and controversially discussed during the past thirty years (Holender, 1986; Kinoshita & Lupker, 2013; Marcel, 1983). The debate focused mainly on whether or not the priming effects of unconsciously perceived stimuli are real. Several masked priming studies indicated that unconscious priming can be achieved under specific conditions that include presenting the primes for very short durations (30-60 ms), between forward and backward masking stimuli, and objectively measuring the prime visibility (e.g., Beyersmann et al., 2019; Grainger & Holcomb, 2008; Holcomb & Grainger, 2006, 2007; Kiefer & Spitzer, 2000; Zhang & Damian, 2019). In the masked priming procedure, the prime stimulus is briefly presented and immediately replaced by a pattern mask (e.g., a series of letters or symbols occupying the same spatial location as the prime) or, in some cases, by the target stimulus itself. Participants are usually unable to report having seen the primes. Unmasked target stimuli are typically associated with faster response times (RTs) and fewer errors when they follow an identity or semantically related masked prime. Past and recent studies indicate that word properties (e.g., visual, orthographic, semantic and phonological features) can be extracted even under masking conditions, outside of people's awareness (Bowers et al., 1998; Dehaene et al., 2001; De Wit & Kinoshita, 2015; Peressotti et al., 2012; Pesciarelli et al., 2007). This led to the conclusion that masked priming reflects unconscious mechanisms of word processing (Marcel, 1983). Although there is still debate about the models explaining unconscious semantic effects (for overviews, see De Wit & Kinoshita, 2015; Rohaut et al., 2016), consensus instead exists that in the masked priming paradigm the mask interferes with the consolidation of long-lasting episodic memories. Therefore, this paradigm is well suited to investigate (a) the neural correlates of the unconscious processing of gender stereotypes and (b) the early stages of gender stereotype activation. However, to the best of our knowledge, the neural correlates of gender stereotypes processing have never been investigated comparing stimuli presented above and below threshold.

ERP studies on the automatic activation of gender stereotype in language showed that the N400 (an increase in negativity usually unfolding over a 300–500 ms time-window elicited by targets presented within semantically incongruent contexts, Kutas & Hillyard, 1980) is modulated by the violation of gender stereotypes (e.g., Irmen et al., 2010; Molinaro et al., 2016; Osterhout et al., 1997; Proverbio et al., 2018, 2017; Siyanova-Chanturia et al., 2012; Wang et al., 2017; White et al., 2009). Proverbio et al. (2017) also reported a Left Anterior Negativity (LAN) effect for gender incongruent words further confirming the automatic processing of gender stereotypes. P600 effects associated with gender stereotyped words or phrases have been reported as well (i.e., a positive shift emerging over a 500–900 ms time-window elicited by stimuli that either are syntactically incongruent or require repair and reanalysis to be integrated, e.g., Canal et al., 2015; Irmen et al., 2010; Lattner & Friederici, 2003; Osterhout & Holcomb, 1995; Osterhout et al., 1997; Proverbio et al., 2018; Wang et al., 2017). Adapting a paradigm originally proposed by Banaji and Hardin (1996), Siyanova-Chanturia et al.'s (2012) asked Italian participants to judge the grammatical gender of a personal pronoun (*lui* or lei, *he* or *she*) following either a grammatically marked role noun (e.g., *passeggera*$_{\text{FEM}}$ "passenger", *pensionato*$_{\text{MASC}}$ "pensioner") or a grammatically unmarked role noun associated to a specific gender stereotype (bigender nouns as, for instance, *insegnante* "teacher", *conducente* "driver", respectively associated to a female and male-oriented stereotypes). N400 effects emerged when the pronouns were preceded by grammatically incongruent primes (*passeggera*$_{FEM}$ – *lui*$_{MASC}$; *pensionato*$_{MASC}$ – *lei*$_{FEM}$), or by stereotypically incongruent primes but in this case only when masculine pronouns were preceded by stereotypically female antecedents (*insegnante* – *lui*). In addition, a P300 effect emerged, but only on female participants, when the pronouns were preceded by grammatically incongruent primes.

To assess whether gender stereotypes indeed are unconsciously activated upon presentation of stereotyped role nouns, we used an unmasked/masked priming technique and the same materials and paradigm of Siyanova-Chanturia et al. (2012). The primes were occupational role nouns that differed in whether or not they were associated to gender stereotypes and whether or not they were grammatically marked for gender. Specifically, we had bigender role nouns, not marked for grammatical gender, either associated to a male- or female-oriented gender stereotype or stereotype-neutral, and role nouns stereotypically neutral but grammatically marked for gender as reflected by the final vowel "-a" (FEM) or "-o" (MASC) (plus a further condition ending in "-e" for fillers word, see below). In Italian, as in other romance languages, the final vowel is a powerful cue to gender (Caffarra et al., 2013; Padovani et al., 2004). The primes were presented for an extremely short lag (50 ms). In the masked condition, they were masked by backward and forward masking stimuli; in the unmasked condition, the masking stimuli were replaced by a black screen of the same duration of the mask. Each prime was followed by an Italian masculine or a feminine singular personal pronoun. We analyzed the RTs and ERP amplitude differences at various latencies post-target pronoun onset (for full details see the Method section).

If indeed gender stereotype priming occurs outside conscious awareness, it should emerge also in the masked condition. Specifically, given that we used the same task and experimental materials of Siyanova-Chanturia et al. (2012), we should replicate the results of their study in both the masked and unmasked conditions. We should observe N400 effects on the pronouns preceded by grammatically incongruent primes (e.g., *passeggera*$_{FEM}$ – *lui*$_{MASC}$; *pensionato*$_{MASC}$ – *lei*$_{FEM}$), and on stereotypically incongruent primes when followed by masculine pronouns (*insegnante* – *lui*). In fact, in Siyanova-Chanturia et al., as in some other studies (Canal et al., 2015; Osterhout et al., 1997), the brain response to masculine and feminine pronouns differed. Also, the gender of participants can make the difference: for instance, Proverbio et al. (2018) reported a N400 effect for male but not female participants, and larger when male participants read sentences concerning male characters. Barber and Carreiras (2003), as Siyanova-Chanturia et al., found a P300 effect on grammatical gender violations in word-pairs while participants performed a binary decision task. Since in our study we employed a similar experimental manipulation (i.e., word pairs and a binary decision task), we may also observe P300 effects on pronouns preceded by grammatically incongruent primes. Finding masked priming effects will provide crucial evidence to the claim of automaticity of the activation of gender stereotypes in language processing.

2. Method

2.1. Ethics statement

This study was carried out in accordance with the recommendations of the "Italian Association of Psychology" (AIP) Ethical Guidelines (*Codice Etico*: www.aipass.org/node/11560) and with the standard procedures of the University of Modena-Reggio Emilia. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

2.2. Participants

Twenty-six students at the University of Modena and Reggio Emilia (13 women; age range: 19-26 yrs, M=20 yrs) participated in the experiment for course credit. All participants were right-handed (L.Q. = + 87, Decile R.7) as assessed with an Italian version of the Edinburgh Handedness Inventory (Oldfield, 1971). Participants had no history of neurological or mental disorders, and had normal or corrected-to-normal visual acuity. All participants were native Italian-language monolingual speakers.

2.3. Stimuli

We used the same stimuli of Siyanova-Chanturia et al. (2012), that is: stereotypically male and stereotypically female bi-gender role nouns (e.g., *conducente* "driver", *insegnante* "teacher", respectively); stereotypically neutral role nouns that could be grammatically masculine or feminine (e.g., *pensionato* "pensioner", *passeggera* "passenger", respectively) and neutral bi-genders ending in –e (a word ending equally associated to both grammatical genders, e.g., *conoscente* "acquaintance"). The latter were included as fillers to prevent participants from noticing the presence of the gender stereotyped words. Siyanova-Chanturia et al. normed the stimuli for stereotypicality and valence (see Table 1 and Appendix; see also Siyanova-Chanturia et al. (2012) for more details) as follows: 260 words were presented to 40 participants who were asked to rate the extent to which each word was associated with men or women, or both, using a seven-point Likert scale. The 60 words selected as experimental primes in the stereotypical gender condition received equally high ratings of male-oriented or female-oriented stereotypicality (Table 1). To avoid any interference of the gender-to-ending consistency typical of Italian, all the stimuli in the stereotypical condition ended in –e or in a consonant. Thirty primes had an associated male stereotype (e.g., conducente, *driver*), and 30 had an associated female stereotype (e.g., insegnante, *teacher*) (see Appendix). In order to select 60 items without any stereotypical bias for the grammatical condition, 40 students rated for stereotypicality 138 words with grammatical gender. We selected 60 words whose grammatical gender was morphologically marked in the final vowel and that had no stereotypical associations. A grammatical noun appeared either with a feminine or masculine inflection, but not with both (e.g., pensionato or pensionata) (see Appendix). 40 participants were asked to rate the valence of the experimental words using a seven-point Likert scale (half of the respondents saw: 1 – negative, 4 – neutral, 7 – positive; the other half saw a reversed scale). The four types of stimuli (stereotypically male or female; grammatically male or female) had also been balanced for frequency (La Repubblica corpus) and length (number of characters).

Each prime was followed by a masculine or feminine third-person singular pronoun (*lui*, *he*; *lei*, *she*). Each prime was paired with a singular personal pronoun, grammatically masculine or feminine, so that we had grammatically or stereotypically congruent pairs (grammatical: *pensionato – lui*, *passeggera – lei*; stereotypical: *conducente – lui*, *insegnante – lei*); and grammatically or stereotypically incongruent pairs (grammatical: *pensionato – lei*, *passeggera – lui*; stereotypical: *conducente – lei*, *insegnante - lui*). In each trial of the masked condition, the prime word was preceded and followed by masking stimuli. In each trial of the unmasked condition, the masking stimuli were replaced by a black screen of the same duration of the mask. 300 trials were presented to participant in each condition (30 trials per prime-target pairs) divided in two blocks. The same prime was followed by a feminine pronoun in one block and by a masculine pronoun in another block. The critical stimuli on which ERP data were compared were the target pronouns of each trial. Each participant completed 600 trials. The same prime-target pairs were used in the two conditions. Prime-target pairs were randomized prior to presentation. Before the experiment, participants took part in a short training session with 20 prime-target pairs (10 masked and 10 unmasked, half grammatically masculine and half feminine) formed by stimuli different from the experimental ones.

2.4. Design and Procedure

Participants were seated comfortably in a darkened sound-attenuated room. An example of the stimulus presentation procedure is illustrated in Fig. 1.

Fig. 1 and Table 1 about here

All stimuli (4-10 letter strings) were presented in the center of a 17″ CRT monitor synchronous with the screen refresh [Philips 107B; refresh rate = 60 Hz (16.67 ms)] that was positioned at eye level approximately 70 cm in front of the participant, such that each stimulus subtended 1.2–4.1° of horizontal visual angle and 0.5° of vertical visual angle. Stimuli were displayed in light grey uppercase letters (Courier font, size 13) against a black background. E-Prime software (Version 2; Psychology Software Tools, Pittsburgh, PA) was used for stimulus presentation and behavioral response collection. The test computer was a ACPI multiprocessor PC with a D CPU 2.80 GHz Intel Pentium processor, Radeon X550 video card. Priority settings were optimized to ensure accurate display durations. The procedure was modelled on that of Siyanova-Chanturia et al.'s (2012) study. Each trial began with a fixation cross (+) presented in the middle of the screen and stayed there until participants pressed a button to start the trial. Then a black screen was displayed for 500 ms and replaced by a 500 ms forward mask consisting of a row of 10 #s. The forward mask was replaced by the prime stimulus for 50 ms at the same location on the screen. The use of a 50 ms prime stimulus duration was expected to make masking effective and to prevent participants from consciously perceiving the primes. This prime duration has been used successfully for over a decade by behavioral and ERP investigators to study the mechanisms involved in word recognition (e.g., Beyersmann et al., 2019; Holcomb & Grainger, 2006, 2007; Grainger & Holcomb, 2008; Zhang & Damian, 2019). The prime was then immediately followed by a 100 ms backward mask consisting of a row of 10 #s. Then the target pronoun (LEI or LUI) appeared and remained on the screen until a response was made. Each response was followed by a 1000 ms blank screen. The use of prolonged forward and backward mask durations was expected to make masking even more effective preventing participants from consciously perceiving the primes and avoiding selection bias. Similarly to other studies (e.g. Beyersmann et al., 2019; Davis and Kim, 2011: Exp.2 and 3; Holcomb & Grainger, 2006), we used a 500 ms forward mask followed by a 50 ms prime stimulus. Since processing is not limited to the period of stimulus exposure, to prevent the viewer from continuing to process the image after the stimulus has been turned off, we introduced also a backward mask. Consistently with Greenwald et al. (1996), the duration of the post-mask was set to approximately 20% of the duration of the premask, that is 100 ms.

In the unmasked condition, the masking stimuli were replaced by a black screen of the same duration of the mask. The task of the participants was to decide, as quickly and accurately as possible, whether the pronouns was female or male. Participants responded by pressing one of two buttons, which were counterbalanced (left and right) across subjects. An objective measure of prime visibility was obtained after the experiment. Participants were informed of the presence of the prime behind the mask and had to perform lexical decisions on masked prime that could be either a word or a non-word. They received a practice session to ensure that they understood the prime visibility task. Participants were also requested to make the best guess when they felt not confident about the correct response. Data of no participants had to be excluded from the analysis because identification rate did not exceed the confidence interval of chance performance (accuracy greater than 65%). The lexical decision task on the primes confirmed that our masking method rendered the primes largely invisible, as the average accuracy was close to chance [mean percentage correct = 57% (57% female, SD = .06, range 49-64%; 57% male, SD = .08, range 45-64%)]. Accuracy was distributed around the chance level of 50%, which is expected by mere guessing. This objective prime visibility measure overcomes the limitations of subjective self-report measure in which participants report not having seen the stimuli, but may have experienced it consciously (Bernat et al., 2001).

2.5. EEG recording and analysis

EEG was amplified and recorded with the BioSemi Active-Two System from 30 active electrodes placed on the scalp. In addition, four electrodes were placed around the eyes for eye-movement monitoring (two at the external ocular canthi and two below the eyes) and two electrodes were placed over the left and right mastoids. Two additional electrodes were placed close to Cz, the Common Mode Sense [CMS] active electrode and the Driven Right Leg [DRL] passive electrode, that were used to form the feedback loop that drives the average potential of the participant as close as possible to the AD-box reference potential. EEG and EOG signals were amplified and digitized continuously with a sampling rate of 512 Hz. EEG signals were referenced off-line to the average activity of the two mastoids and then analyzed using Brain-Vision Analyzer. After a band-pass filter (0.01–80 Hz band pass), 1200-msec epochs containing the ERP elicited by the target pronoun were extracted, starting with 200 ms prior to the onset of the pronoun. Data with excessive blinks were adaptively corrected using ICA. Segments including artefacts (such as excessive muscle activity) were eliminated off-line before data averaging. Two participants (1 female and 1 male) were excluded from all the analyses due to the high number of rejected epochs (>25%). The lost data (due to artefacts) of the remaining 24 participants were equal to 5,5%. A 200 ms pre-stimulus baseline was used in all analyses. Based on visual inspection of grand average ERP waveforms and in line with previous literature, the following components were identified for target onset at frontal (F3, Fz, F4), central (C3, Cz, C4) and parietal (P3, Pz, P4) scalp sites: N400 from 250 to 400 ms after target onset; P3 from 400 to 550 ms after target onset. For each ERP component amplitude was measured as mean activity within the respective time window.

2.6. Statistical analysis

Behavioral and ERP analyses were carried out only on trials with correct responses and with a latency between 300 and 1500 ms (rejected trials were on average 0.82%). Filler trials were excluded from the analyses. The mean response times (RTs) of correct responses per condition were submitted to analyses of variance (ANOVAs) with Masking (unmasked, masked), Prime Type (grammatical, stereotypical), Prime Gender (female, male), and Target Gender (feminine, masculine) as within-subject factors. Hit rates were not statistically analyzed because of ceiling effects, with all conditions averaging 98% correct.

ERP effects time-locked to the onset of the target were evaluated taking into account 6 clusters of electrodes representing the mean amplitude of three electrodes in close position: Anterior (F3, Fz, F4), Central (C3, Cz, C4), Posterior (P3, Pz, P4), Left (F3, C3, P3), Midline (Fz, Cz, Pz), Right (F4, C4, P4). ANOVAs were conducted on mean ERP amplitudes with Masking (unmasked, masked), Prime Type (grammatical, stereotypical), Prime Gender (female, male), Target Gender (feminine, masculine), Longitude (anterior, central, posterior) and Latitude (left, midline, right) as within-subject factors. Visual inspection revealed differences in the responses to gender-congruent pronouns in two time windows (250–400 ms and 400–550 ms) following pronoun onset. Statistical analyses on mean amplitude values were carried out in the 250–400 ms and 400–550 ms time windows.

In addition, separate ANOVAs were run on the masked and unmasked conditions. When appropriate, degrees of freedom were adjusted according to the method of Greenhouse-Geisser; only corrected significance levels are reported. The level of significance testing was $p = .05$.

As the effects under investigation might be influenced by the participant's gender, an exploratory analysis was conducted by including, in all ANOVAs, a between-subject Participant Gender factor (male, female). Despite the small sample size for each gender (12 females vs 12 males) may limit conclusive inferences, our results can provide useful suggestions for future behavioral and ERP studies on implicit gender stereotypes processing. Post-hoc mean comparisons (Newman-Keuls test) were employed to further examine significant effects (using a $p < .05$ criterion for significance). The main effects of Masking, Prime Type, Prime Gender, Target Gender, Participant Gender, and electrode position are not central to the questions under study. Therefore, they are reported and not discussed since we discuss only the interactions of interest to the study.

3. Results

3.1. Behavioral results

Participants were unable to identify the primes. Fig. 2 shows the mean RTs to pronouns preceded by congruent and incongruent grammatical and stereotypical primes. The omnibus ANOVA conducted on the RT data yielded a significant main effect of Masking [$F(1, 22) = 11.71$, $p < .01$, $\eta_p^2 = .35$, observed power = .90] revealing faster RTs for the masked than unmasked condition and a significant Prime Gender x Target Gender interaction [$F(1, 22) = 34.5$, $p < .0001$, $\eta_p^2 = .61$, observed power = .99], regardless of masking. The faster RTs for pronouns preceded by congruent than incongruent grammatical and stereotypical primes indicate clear priming effects in both cases (all ps < .01). We also found a significant Prime Type x Prime Gender x Target Gender interaction [$F(1, 22) = 7.5$, $p < .05$, $\eta_p^2 = .25$, observed power = .74] revealing a larger priming effect for grammatical than stereotypical primes, regardless of masking (all ps < .01), and a significant Prime Type x Prime Gender x Target Gender x Participants gender interaction [$F(1, 22) = 8.4$, $p < .01$, η_p^2

= .28, observed power = .79], which is suggestive of a larger priming effect for grammatical than stereotypical primes more pronounced in female than male participants (all ps < .01).

Fig. 2 about here

3.2. ERP results

Grand-averaged ERPs elicited by the different experimental conditions are represented in Fig. 3 and 4.

Fig. 3 and 4 about here

3.2.1. N400

The omnibus ANOVA showed significant main effects of Masking [$F(1, 22) = 44.4$, $p < .0001$, $\eta_p^2 = .67$, observed power = .99], with more negative waveforms for the unmasked than for the masked condition, of Prime Type [$F(1, 22) = 10.1$, $p < .01$, $\eta_p^2 = .32$, observed power = .86], indicating a more negative brain response for the stereotypical than for the grammatical condition, and of Target Gender [$F(1, 22) = 9.5$, $p < .01$, $\eta_p^2 = .30$, observed power = .84], suggesting a more negative amplitude for grammatically masculine than feminine pronouns. Significant Masking x Prime Type x Target Gender x Participant Gender [$F(1, 22) = 4.3$, $p < .05$, $\eta_p^2 = .16$, observed power = .51], and Latitude x Masking x Prime Type x Prime Gender x Target Gender x Participant Gender [$F(2, 44) = 5.3$, $p < .01$, $\eta_p^2 = .19$, observed power = .81] interactions were also obtained. To further explore these interactions, separate analyses for the Masking factor (Unmasked vs. Masked) were conducted. The analysis of the Unmasked condition showed a significant main effect of Target Gender [$F(1, 22) = 7.7$, $p < .01$, $\eta_p^2 = .26$, observed power = .76], with more negative brain response for masculine than feminine pronouns. A significant Longitude x Prime Gender x Target Gender interaction [$F(2, 44) = 4.7$, $p < .05$, $\eta_p^2 = .18$, observed power = .76] was also obtained, with more negative waveforms for incongruent than for congruent pronouns (i.e., a priming effect) in the central-parietal area (all ps < .01). The analysis of the masked condition showed significant main effects of Prime Gender [$F(1, 22) = 4{,}6$, $p < .04$, $\eta_p^2 = .17$, observed power = .54], indicating more negative waveforms for masculine than feminine pronouns, and of Target Gender [$F(1, 22) = 4{,}7$, $p < .04$, $\eta_p^2 = .17$, observed power = .54], with a more negative amplitude for masculine than feminine pronouns. The ANOVA also revealed a significant Latitude x Prime Gender x Target Gender x Participant Gender interaction [$F(2, 44) = 3.4$, $p < .05$, $\eta_p^2 = .13$, observed power = .61], with a larger masked priming effect in the left-midline area that seems more pronounced in female participants (all ps < .01).

3.2.2. P300

The N400 was followed by a positive waveform identified as a P300 component. The omnibus ANOVA revealed a main effect of Masking [$F(1, 22) = 34{,}5$, $p < .0001$, $\eta_p^2 = .61$, observed power = .99], with more positive waveforms for the masked than for the unmasked condition. The ANOVA also showed the following significant interactions: Masking x Prime Gender x Target Gender [$F(1, 22) = 9.8$, $p < .01$, $\eta_p^2 = .31$, observed power = .85], Latitude x Masking x Prime Gender x Target Gender x Participant Gender [$F(2, 44) = 3.4$, $p < .05$, $\eta_p^2 = .13$, observed power = .61], and Longitude x Masking x Prime Type x Prime Gender x Target Gender x Participant Gender [$F(2, 44) = 4.6$, $p < .05$, $\eta_p^2 = .16$, observed power = .71]. To further explore these interactions, the unmasked and masked conditions were analyzed separately. In the unmasked condition, we found a significant Prime Gender x Target Gender interaction [$F(1, 22) = 4.0$, $p < .05$, $\eta_p^2 = .16$, observed power = .48]. Post hoc analyses revealed a more positive brain response to the grammatical violation emerging when participants judged masculine pronouns preceded by incongruent grammatical primes. ($p < .05$). This effect was more pronounced in the left-midline region and more evident in female participants, as suggested by a significant Latitude x Prime Gender x Participant Gender interaction [$F(2, 44) = 4.2$, $p < .05$, $\eta_p^2 = .16$, observed power = .70]. In the masked condition, two significant interactions emerged: (1) Longitude x Prime Gender x Target Gender x

Participant Gender [$F(2, 44) = 3.9$, $p < .05$, $\eta_p^2 = .15$, observed power = .67], indicating more positive waveforms (i.e., a larger masked priming effect) in the centro-parietal area which seem more pronounced for female participants (all ps < .01); (2) Longitude x Prime Type x Prime Gender x Target Gender x Participant Gender [$F(2, 44) = 3.5$, $p < .05$, $\eta_p^2 = .14$, observed power = .62]. To further investigate the latter five-way interaction, separate ANOVAs were run. Prime Gender specific comparisons revealed a more positive brain response only when participants judged masculine pronouns preceded by incongruent grammatical primes, as in the unmasked condition [$F(1, 22) = 5.1$, $p < .05$, $\eta_p^2 = .19$, observed power = .58]. No significant effects were found for stereotypical primes.

4. Discussion

In this masked and unmasked priming study, we explored the neural correlates of the activation of gender stereotypes in language, and whether and the extent to which these effects occurred outside consciousness. We adopted the semantic priming paradigm originally proposed by Banaji and Hardin (1996), subsequently used by Siyanova-Chanturia et al. (2012) in the ERP study that inspired the present experiment. In our study, participants were required to judge the grammatical gender of a singular personal pronoun ignoring the preceding word prime that was presented in a masked or an unmasked way. Grammatically-marked or stereotypically-associated role nouns acted as primes.

The behavioral and ERP findings (especially for the N400) revealed a consistent pattern of results. Specifically, we obtained priming effects leading to slower reaction times and larger negativities, in both the masked and unmasked conditions, when the pronouns were preceded by gender-incongruent than gender-congruent grammatical and stereotypical primes.

In the late positivity time window (identified as a P300 component), the effects found in both the masked and unmasked conditions were due to the grammatical gender mismatch between the antecedent and the pronoun (*pensionato*$_{\text{MASC}}$-*lei*$_{FEM}$) and were more pronounced in female than male participants. Interestingly, the absence of a P300 effect for stereotypical gender suggests that stereotypical and grammatical gender may reflect different types of knowledge: semantic knowledge for grammatical gender (Garnham et al., 2002), and pragmatic, world-knowledge for stereotypical gender (Contreras et al., 2011; Hagoort et al., 2004). While the behavioral and N400 results in the unmasked condition basically replicate those of prior studies, the results of the masked condition represent an original and new contribution to the study of gender stereotype processing (we return on this point below).

The P300 effects observed in this study in the unmasked condition are consistent with those observed in Siyanova-Chanturia et al., as it is the female prevalence of the effect. In contrast, the N400 effects partly differ since while we found a N400 on the pronouns preceded by both grammatically and stereotypically incongruent primes, Siyanova-Chanturia et al. (2012) only observed this effect when stereotypically female antecedents were followed by mismatching pronouns (e.g., *insegnante-lui*). In other terms, here we showed that the brain sensitivity to the violation of the anaphorical match between antecedent and pronoun is similar no matter whether the antecedent was a stereotypically or a grammatically marked role noun (cfr. Molinaro et al., 2016; White et al., 2009).

In this study, the analyses with participant gender as a between-subject factor, although exploratory, suggest that the response times and waveforms of female and male participants may differ at various levels. It is important to note that when assessing implicit biases as stereotypes, between factors are often difficult to interpret without an extremely large sample size. Nevertheless, our findings could still be interesting as they show possible participant gender differences on gender stereotypes processing. In fact, female participants showed larger behavioral priming effects for grammatical than stereotypical primes in both the masked and unmasked conditions. Then, in the masked condition, females had larger N400 effects for pronouns preceded by incongruent grammatical and stereotypical primes. Finally, in the unmasked condition, females showed larger P300 effects when masculine pronouns were preceded by incongruent grammatical primes. Given the small gender sample size of our study, further research under the same masking condition is needed. However, it is worth of note that similar participant gender differences have been reported in other studies as well. For instance, Osterhout et al. (1997) found larger P600 amplitudes for females than males in both grammatical and stereotypical gender violations. Siyanova-Chanturia et al. (2012) found P300 gender differences but only for pronouns preceded by grammatically incongruent primes. Canal et al. (2015) found differential P600 effects but again for grammatical gender mismatching pronouns. These gender differences have been basically attributed to a more pronounced sensitivity of females toward grammatical violations that reflects their superiority in language-related skills (e.g., grammar, verbal fluency, and articulation speed; Siegel, 2001; Rosenberg & Sutton-Smith, 1969). Proverbio et al. (2018), as well, found participants gender effects.

Previous studies reported a gender stereotype asymmetry (Cacciari & Padovani, 2007; Irmen et al., 2010; Siyanova-Chanturia et al., 2012) in the behavioral and/or ERP responses to masculine and feminine pronouns when preceded by stereotypical gendered role nouns. This led to slower and/or more negative waveforms when stereotypically female role nouns were followed by grammatically masculine pronouns (e.g., *insegnante-lui*). Differently, in the present study, the waveforms obtained in masked and unmasked conditions revealed a gender asymmetry in the P300 effects only when masculine pronouns were preceded by grammatically mismatching antecedents (e.g. *passeggera*$_{\text{FEM}}$-*lui*$_{\text{MASC}}$). How can we account for this discrepancy? One possibility, to be explored in future studies, is related to the different status of the grammatical and stereotypical violations triggered by a gender mismatch between pronoun and antecedent. In fact, as noted by Canal et al. (2015), while grammatical information determines the antecedent gender categorically, stereotypical gender information represents a probabilistic bias that may or may not drive the assignment of a female/male feature to a role noun. This grammatical gender mismatch effect only concerned masculine pronouns presumably because of the "unmarked" nature of the masculine gender that is by default assigned whenever specific information about the biological gender of the person is unknown or thought to be irrelevant.

The P300 effects observed in this study in the unmasked condition replicated Siyanova-Chanturia et al.'s results (2012). In contrast, our N400 effects partly differ since while we found these effects when the pronouns were preceded by both grammatically and stereotypically incongruent primes, Siyanova-Chanturia et al. (2012) only found the N400 in a specific condition, namely when grammatically masculine pronouns were preceded by stereotypically female antecedents (e.g., *insegnante-lui*). We interpret the late positivity found in this study, and in Siyanova-Chanturia et al. (2012) for grammatical gender violations, as a P300 effect. A similar P300 component has been found in priming experiments for grammatical gender disagreement where a binary decision task and a fast judgment were required (Barber & Carreiras, 2003; Bentin et al., 1985). It is important to note that although the P300 component peaks around 300 ms, some studies showed delayed peak and latency depending on the experimental manipulations (Chwilla et al., 2000; Kutas et al., 1977, Roehm et al., 2007). Moreover, some authors indicated that the P300 effect may follow the N400 and thus it may peak later than 300 ms after stimulus presentation (Chwilla et al., 2000; Roehm et al., 2007).

Taken together our results further confirm the important on-line effect of gender stereotype on language processing (Carreiras et al., 1996; Ellemers, 2018; Garnham et al., 2002; Oakhill et al., 2005; Proverbio et al., 2018, 2017; Siyanova-Chanturia et al., 2012, 2015). But for the first time, to the best of our knowledge, we provided clear evidence that these effects occur even without conscious inferences. In fact, our masked priming effect on pronouns preceded by stereotypical as well as grammatical role nouns can only be due to participants having unconsciously processed the primes, confirming and extending the assumption that the activation of stereotypical knowledge is automatic and immediate. In sum, we provide important neural evidence in favor of the "Immediacy hypothesis" (Carreiras et al., 1996; Garnham et al., 2002) according to which information about stereotypical gender is incorporated into the representation underlying word or sentence processing as soon as it becomes available.

4.1. Conclusion

To the best of our knowledge, this is the first study that investigated the neural correlates of the conscious and unconscious processing of gender stereotypes by comparing the ERP waveforms triggered by stimuli presented above and below threshold. Once again, we provided evidence that indeed gender stereotypes influence language processing but, differently from other studies, our evidence directly speaks in favor of an immediacy and automaticity of these effects. Although in recent years researchers developed several important methods to investigate the implicit processing of stereotypes, most of them rely on measures that also involve a conscious appreciation of the stimuli. The masked priming paradigm is particularly well suited to investigate the unconscious activation of stereotypic beliefs and their behavioral and neural basis since it taps on processes occurring outside of consciousness.

Funding

The research leading to these results has received funding from the European Community's Seventh Framework Program (FP7/2007-2013) under grant agreement n° 237907. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Figure captions

Fig. 1. Schematic depiction of the unmasked and masked procedures used in the present experiment.

Fig. 2. Mean reaction times to target pronouns separately for the unmasked (left panel) and masked (right panel) procedures as a function of prime-target congruency (congruent vs incongruent) and prime type (grammatical vs stereotypical). Error bars represent standard errors of the mean.

Fig. 3. Grand-averaged ERP waveforms elicited by target pronouns separately for the unmasked (top panel) and masked (bottom panel) procedures as a function of prime-target congruency (congruent vs incongruent) and prime type (grammatical vs stereotypical).

Fig. 4. Topographical scalp distributions for target pronouns separately for the unmasked (left panel) and masked (right panel) procedures as a function of prime type (grammatical vs stereotypical) in the two critical time windows, created by subtracting incongruent grammatical and stereotypical conditions from congruent grammatical and stereotypical ones, respectively.

References

Banaji, M. R., & Hardin, C. D. (1996). Automatic stereotyping. *Psychological Science,* 7, 136 141.

Barber, H.A., & Carreiras, M. (2003). Integrating gender and number information in Spanish word pairs: An ERP study. *Cortex,* 39, 465 482.

Bentin, S., McCarthy, G., Wood, C.C. (1985). Event-related potentials, lexical decision and semantic priming. *Electroencephalography and Clinical Neurophysiology,* 60, 343 355.

Bernat, E., Bunce, S., & Shevrin, S. (2001). Event-related brain potentials differentiate positive and negative mood adjectives during both supraliminal and subliminal visual processing. *International Journal of Psychophysiology*, 42, 11-34.

Beyersmann, E., Grainger, J., & Castles, A. (2019). Embedded stems as a bootstrapping mechanism for morphological parsing during reading development. *Journal of Experimental Child Psychology*, *182*, 196 210. https://doi.org/10.1016/j.jecp.2019.01.010

Bowers, J. S., Vigliocco, G., & Haan, R. (1998). Orthographic, phonological, and articulatory contributions to masked letter and word priming. *Journal of Experimental Psychology: Human Perception and Performance*, *24*(6), 1705 1719. http://doi.org/10.1037//0096-1523.24.6.1705

Cacciari, C., & Padovani, R. (2007). Further evidence of gender stereotype priming in language: Semantic facilitation and inhibition in Italian role nouns. *Applied Psycholinguistics*, *28*(2), 277 293. http://doi.org/10.1017/S0142716407070142

Caffarra, S., Pesciarelli, F. & Cacciari, C. (2013). The interaction between language and visual spatial attention systems in grammatical gender processing. An N2pc study. *Cognitive Neuroscience*, 4, 3-4, 217-224.

Canal, P., Garnham, A., & Oakhill, J. (2015). Beyond Gender Stereotypes in Language Comprehension: Self Sex-Role Descriptions Affect the Brain's Potentials Associated with Agreement Processing. *Frontiers in Psychology*, *6*(9), 390 17. http://doi.org/10.3389/fpsyg.2015.01953

Carreiras, M., Garnham, A., Oakhill, J., & Cain, K. (1996). The Use of Stereotypical Gender Information in Constructing a Mental Model: Evidence from English and Spanish. *The Quarterly Journal of Experimental Psychology - Section A*, *49*(3), 639–663. http://doi.org/10.1080/713755647

Chwilla, D.J., Kolk, H.H.J., & Mulder, G. (2000). Mediated priming in the lexical decision task: Evidence from event-related brain potentials and reaction time. *Journal of Memory and Language,* 42, 314–341.

Contreras J. M., Banaji M. R., & Mitchell J. P. (2011). Dissociable neural correlates of stereotypes and other forms of semantic knowledge. *Social cognitive and affective neuroscience*, 7, 764–770.

De Wit, B. & Kinoshita, S. (2015). The masked semantic priming effect is task dependent. Reconsidering the automatic spreading activation process. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 41(4):1062-75. doi: 10.1037/xlm0000074.

Dehaene, S., Naccache, L., Cohen, L., Le Bihan, D., Mangin, J.F., Poline, J.B., & Rivière, D. (2001). Cerebral mechanisms of word masking and unconscious repetition priming. *Nature Neuroscience*, *4*(7), 752–758. http://doi.org/10.1038/89551

Davis, C., & Kim, J. (2011) What's in a mask? Information masking with forward and backward visual masks. The Quarterly Journal of Experimental Psychology, 64, 1990–2002.

Ellemers, N. (2018). Gender Stereotypes. *Annual Review of Psychology*, *69*(1), 275–298. http://doi.org/10.1146/annurev-psych-122216-011719

Fabre, E. F., Causse, M., Pesciarelli, F., & Cacciari, C. (2015). Sex and the money – How gender stereotypes modulate economic decision-making: An ERP study. *Neuropsychologia*, 75, 221-232.

Fabre, E. F., Causse, M., Pesciarelli, F., & Cacciari, C. (2016). The Responders' Gender Stereotypes Modulate the Strategic Decision-Making of Proposers Playing the Ultimatum Game. *Frontiers in Psychology*, 75, 221-232. doi: 10.3389/fpsyg.2016.00012

Garnham, A., Oakhill, J., & Reynolds, D. (2002). Are inferences from stereotyped role names to characters' gender made elaboratively? *Memory & Cognition*, *7* (12). http://doi.org/10.3758/BF03194944

Grainger, J., & Holcomb, P. J. (2008). Neural Constraints on a Functional Architecture for Word Recognition. In *In The Neural Basis of Reading (Vol. 107, pp. 623–658). Oxford University Press.*

Greenwald, A.G., Draine, S.C. & Abrams, R.L. (1996) Three Cognitive Markers of Unconscious Semantic Activation. Science, 273, 1699-1702.

Hagoort, P., Hald, L., Bastiaansen, M., & Petersson, K. (2004). Integration of word meaning and world knowledge in language comprehension. *Science*, 304, 438– 441.

Holcomb, P. J., & Grainger, J. (2006). On the time course of visual word recognition: An event-related potential investigation using masked repetition priming. *Journal of Cognitive Neuroscience*, *18*(10), 1631–1643. https://doi.org/10.1162/jocn.2006.18.10.1631

Holcomb, P. J., & Grainger, J. (2007). Exploring the temporal dynamics of visual word recognition in the masked repetition priming paradigm using event-related potentials. *Brain Research*, *1180*(1), 39–58. https://doi.org/10.1016/j.brainres.2007.06.110

Holender, D. (1986). Semantic activation without conscious identification in dichotic listening, parafoveal vision, and visual masking: A survey and appraisal. *Behavioral and brain Sciences,* 9, 1-66.

Irmen, L., Holt, D. V., & Weisbrod, M. (2010). Effects of role typicality on processing person information in German: Evidence from an ERP study. *Brain Research*, *1353*(C), 133–144. http://doi.org/10.1016/j.brainres.2010.07.018

Kiefer, M., & Spitzer, M. (2000). Time course of conscious and unconscious semantic brain activation. *Neuroreport,* 11, 2401-2407.

Kinoshita, S., & Lupker, S. J. (2013). Masked Priming: The State of the Art. New York: Psychology Press.

Kutas, M., & Hillyard, S. A. (1980). Reading Senseless Sentences: Brain Potentials Reflect Semantic Incongruity. *Science*, *207*, 203–205.

Lattner, S., & Friederici, A. D. (2003). Talker's voice and gender stereotype in human auditory sentence processing–evidence from event-related brain potentials. *Neuroscience Letters*, *339*, 191–194. http://doi.org/10.1016/S0304-3940(03)00027-2

Marcel, A. J. (1983). Conscious and unconscious perception: Experiments on visual masking and word recognition. *Cognitive Psychology*, *15*(2), 197–237. http://doi.org/10.1016/0010-0285(83)90009-9

Molinaro, N., Su, J. J., & Carreiras, M. (2016). Stereotypes override grammar: Social knowledge in sentence comprehension. *Brain and Language*, *155-156*(C), 36–43. http://doi.org/10.1016/j.bandl.2016.03.002

Oakhill, J., Garnham, A., & Reynolds, D. (2005). Immediate activation of stereotypical gender information. *Memory & Cognition*, *33*(6), 972–983. http://doi.org/10.3758/BF03193206

Oldfield, R. C. (1971). The assessment and analysis of handedness: The Edinburgh inventory. *Neuropsychologia*, *9*, 97–113.

Osterhout, L., & Holcomb, P. J. (1995). Event-Related Potentials and Language Comprehension. In Oxford University Press (Ed.), *Rugg, M. D., Coles, M. G. H. Electrophysiology of mind Event-related brain potentials and cognition.* (pp. 1–46).

Osterhout, L., Bersick, M., & Mclaughlin, J. (1997). Brain potentials reflect violations of gender stereotypes. *Memory & Cognition*, *25*(3), 273–285. http://doi.org/10.3758/BF03211283

Padovani, R., Calandra, G., Cacciari, C., Benuzzi, F., Nichelli, P. (2004). Grammatical gender in the brain: Evidence from an fMRI study on Italian. *Brain Research Bulletin*, 65 (4), 301-308.

Peressotti, F., Pesciarelli, F., Mulatti, C., & Dell'Acqua, R. (2012). Event-Related Potential Evidence for Two Functionally Dissociable Sources of Semantic Effects in the Attentional Blink. *PLoS ONE*, *7*(11), e49099–12. http://doi.org/10.1371/journal.pone.0049099

Pesciarelli, F., Kutas, M., Dell'Acqua, R., Peressotti, F., Job, R., & Urbach, T. P. (2007). Semantic and repetition priming within the attentional blink: An event-related brain potential (ERP) investigation study. *Biological Psychology*, *76*(1-2), 21–30. http://doi.org/10.1016/j.biopsycho.2007.05.003

Proverbio, A. M., Alberio, A., & De Benedetto, F. (2018). Neural correlates of automatic beliefs about gender stereotypes: Males are more prejudicial. *Brain and Language*, *186*, 8–16. https://doi.org/10.1016/j.bandl.2018.08.006

Proverbio, A. M., Orlandi, A., & Bianchi, E. (2017). Electrophysiological markers of prejudice related to sexual gender. *Neuroscience*, *358*, 1–12. https://doi.org/10.1016/j.neuroscience.2017.06.028

Roehm, D., Bornkessel-Schlesewsky, I., Rosler, F., & Schlesewsky, M. (2007). To predict or not to predict: Influences of task and strategy on the processing of semantic relations. *Journal of Cognitive Neuroscience,* 19, 1259–1274.

Rohaut, B., Alario, F.-X., Meadow, J., Cohen, L., & Naccache, L. (2016). Unconscious semantic processing of polysemous words is not automatic. *Neuroscience of Consciousness*, 1, 1-19. https://doi.org/10.1093/nc/niw010

Rosenberg, B. G., & Sutton-Smith, B. (1969). Sibling age spacing effects upon cognition. *Developmental Psychology*, 1 (6), 661-668.

Siegel, D. J. (2001). The Developing Mind: How Relationships and the Brain Interact to Shape Who We Are. The Guilford Press.

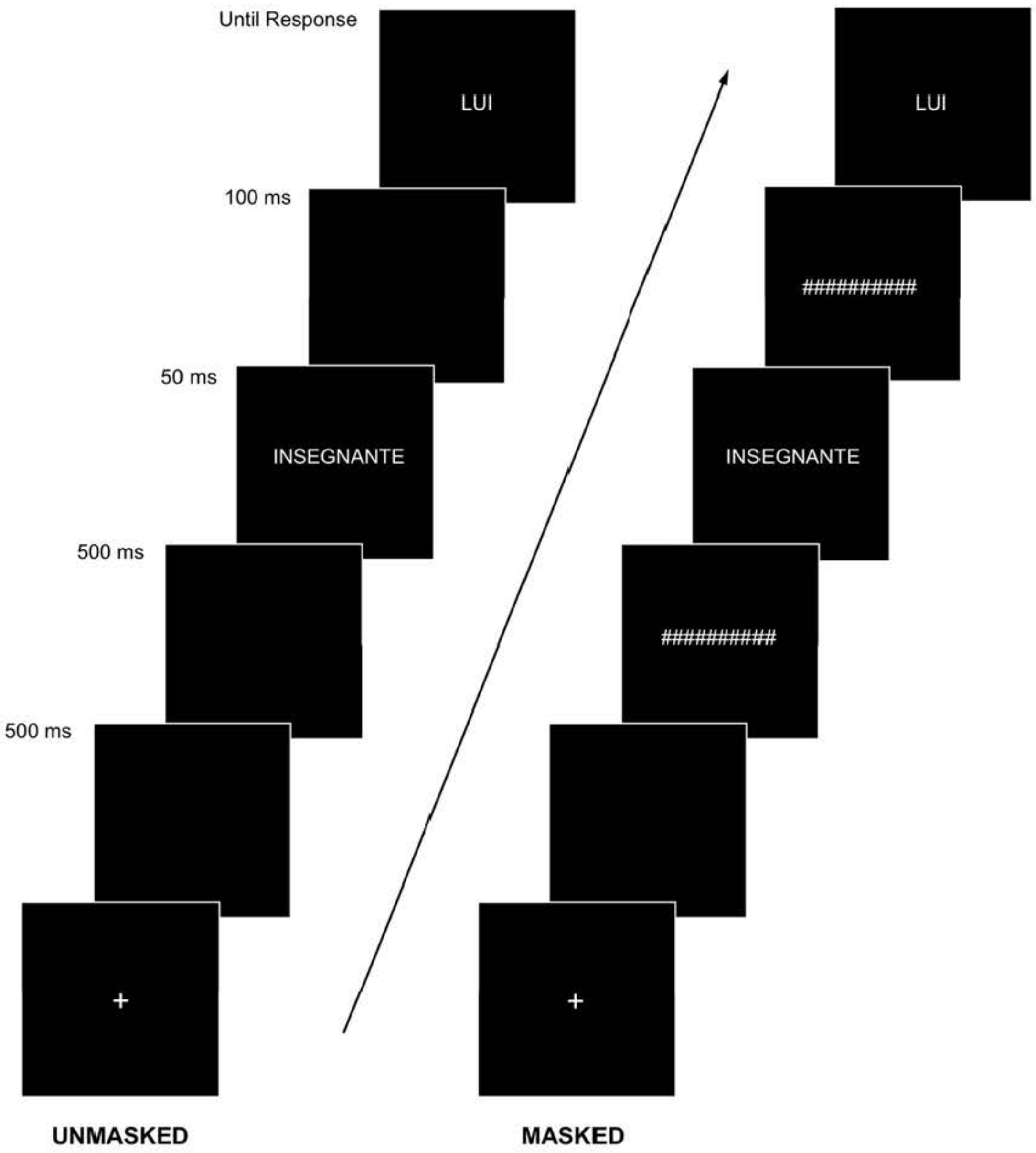
Siyanova-Chanturia, A., Pesciarelli, F., & Cacciari, C. (2012). The Electrophysiological Underpinnings of Processing Gender Stereotypes in Language. *PLoS ONE*, *7*(12), e48712–11. http://doi.org/10.1371/journal.pone.0048712

Siyanova-Chanturia, A., Warren, P., Pesciarelli, F., & Cacciari, C. (2015). Gender stereotypes across the ages: On-line processing in school-age children, young and older adults. *Frontiers in Psychology*, *6*(e48712), 136–13. http://doi.org/10.3389/fpsyg.2015.01388

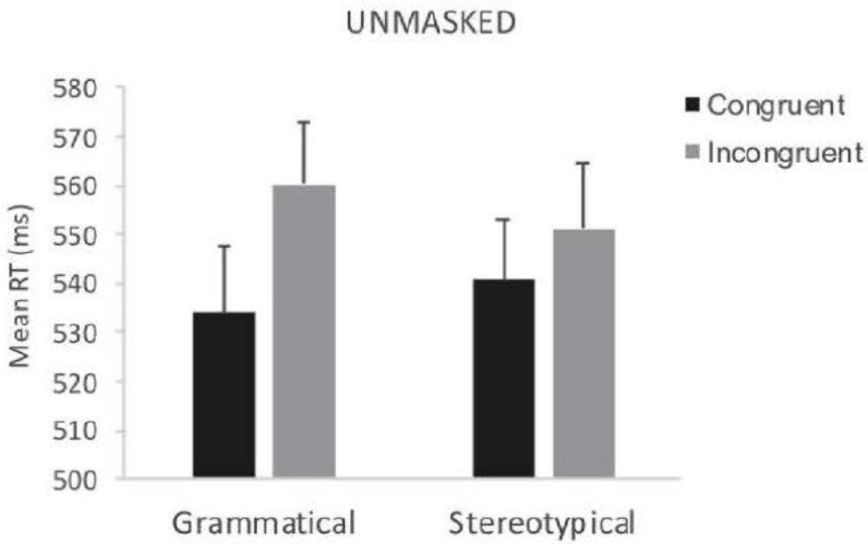
Wang, P., Yang, Y. P., Tan, C. H., Chen, Q. W., & Cantfort, T. (2017). Gender Stereotype Activation versus Lexical Semantic Activation: An ERP Study. *The Journal of General Psychology*, *144*(4), 283–308. http://doi.org/10.1080/00221309.2017.1310714

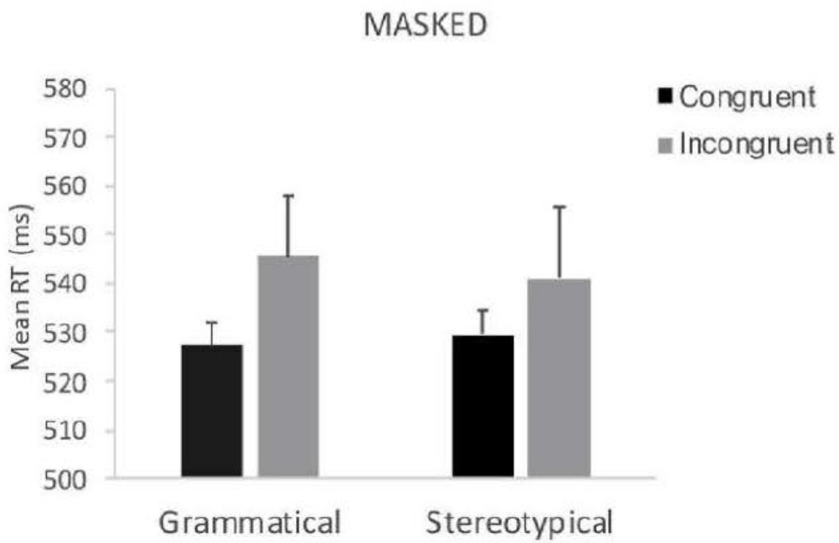
White, K. R., Crites, S. L., Jr, Taylor, J. H., & Corral, G. (2009). Wait, what? Assessing stereotype incongruities using the N400 ERP component. *Social Cognitive and Affective Neuroscience*, *4*(2), 191–198. http://doi.org/10.1093/scan/nsp004

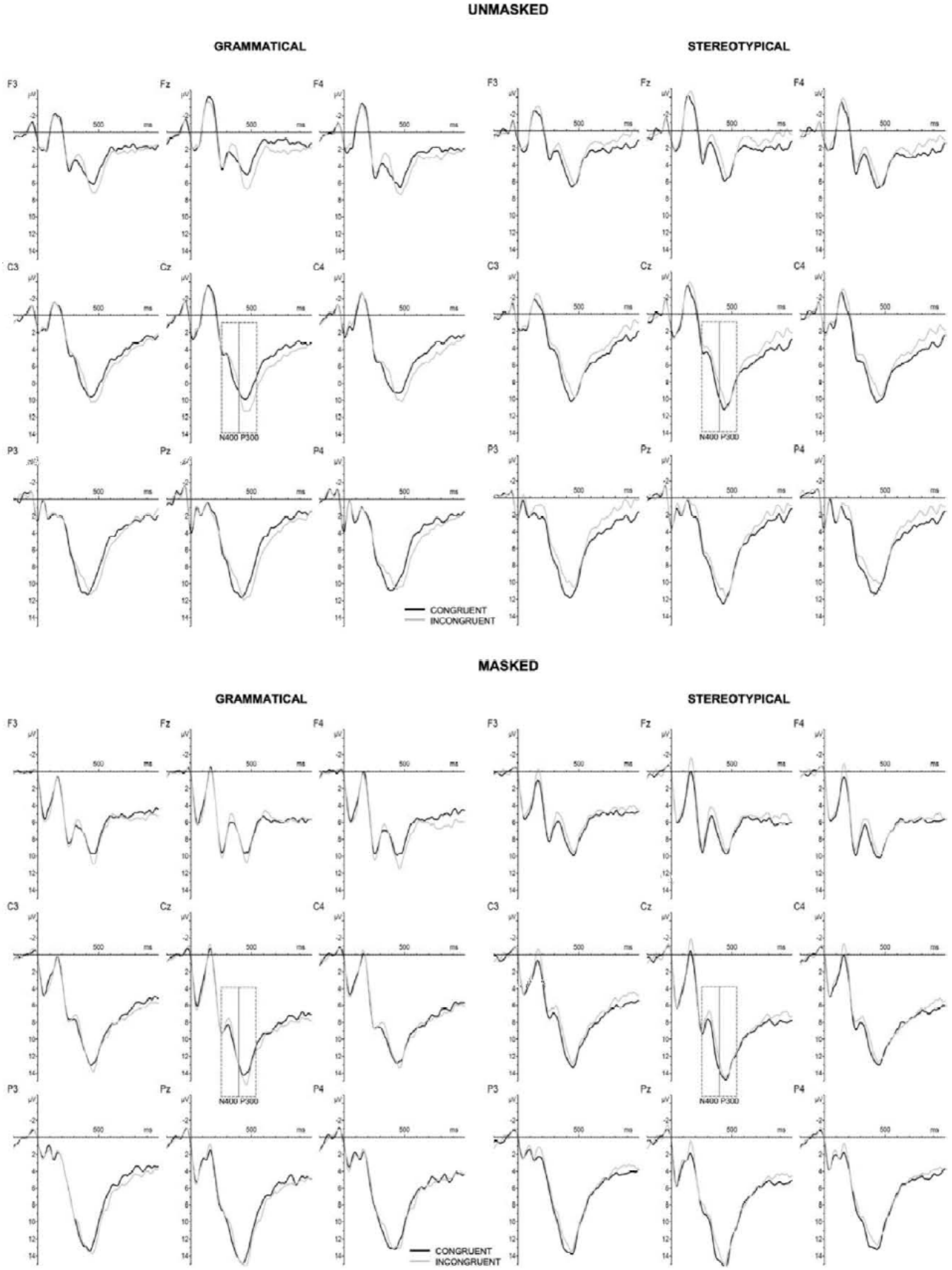
Zhang, Q., & Damian, M. F. (2019). Syllables constitute proximate units for Mandarin speakers: Electrophysiological evidence from a masked priming task. *Psychophysiology*, *56*(4), e13317. https://doi.org/10.1111/psyp.13317



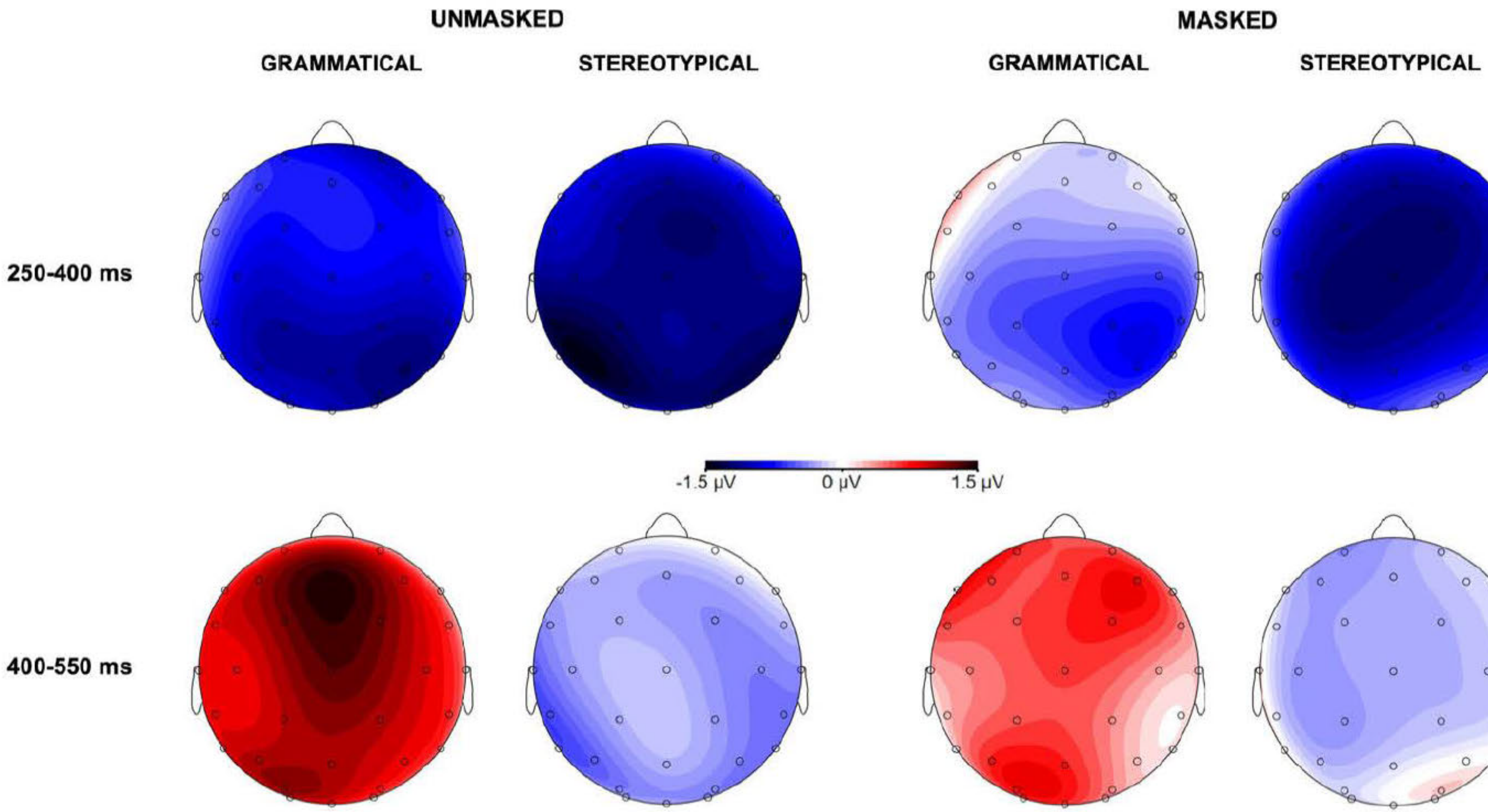
Until Response
LUI
100 ms
50 ms
INSEGNANTE
500 ms
500 ms
+
LUI
##########
INSEGNANTE
##########
+
UNMASKED
MASKED


UNMASKED
580
570
560
550
540
530
520
510
500
Mean RT (ms)
Grammatical
Stereotypical
Congruent
Incongruent


MASKED
580
570
560
550
540
530
520
510
500
Mean RT (ms)
Grammatical
Stereotypical
Congruent
Incongruent



UNMASKED
GRAMMATICAL
STEREOTYPICAL
F3
Fz
F4
C3
Cz
C4
P3
Pz
P4
μV
ms
500
N400 P300
CONGRUENT
INCONGRUENT
MASKED
GRAMMATICAL
STEREOTYPICAL
F3
Fz
F4
C3
Cz
C4
P3
Pz
P4
μV
ms
500
N400 P300
CONGRUENT
INCONGRUENT


UNMASKED
MASKED
GRAMMATICAL
STEREOTYPICAL
GRAMMATICAL
STEREOTYPICAL
250-400 ms
400-550 ms
-1.5 µV
0 µV
1.5 µV

Grammatical		Stereotypical		Fillers
masculine	**feminine**	**masculine**	**feminine**	
ADULTO	NANA	PUGILE	COLF	TUTOR
adult	*dwarf*	*boxer*	*maid*	*tutor*
BIMBO	MUTA	CLOWN	SEXY	OSPITE
baby	*mute*	*clown*	*sexy*	*guest*
SPOSO	AMICA	COACH	DOLCE	PEDANTE
spouse	*friend*	*coach*	*sweet*	*pedant*
VEDOVO	PAGANA	DEEJAY	ESCORT	LICEALE
widower	*pagan*	*deejay*	*escort*	*high school student*
ALUNNO	MATURA	RAPPER	MEDIUM	CONIUGE
pupil	*mature*	*rapper*	*medium*	*consort*
CUGINO	MOROSA	REDUCE	AMANTE	VIVENTE
cousin	*girlfriend*	*veteran*	*lover*	*living*
DILETTO	STUPITA	OREFICE	LOQUACE	PARENTE
beloved	*astonished*	*goldsmith*	*loquacious*	*relative*
COGNATO	ANZIANA	CUSTODE	VERGINE	DOCENTE
brother-in-law	*old woman*	*attendant*	*virgin*	*teacher*
EUROPEO	FIGLIA	GIUDICE	FACILE	PARTNER
European	*daughter*	*judge*	*easy*	*partner*
PURITANO	BISNONNA	FURFANTE	MANICURE	BAGNANTE
puritan	*great-grandmother*	*scoundrel*	*manicurist*	*bather*

Grammatical		Stereotypical		Fillers
masculine	**feminine**	**masculine**	**feminine**	
NIPOTINO	BUGIARDA	MANOVALE	VEGGENTE	DISABILE
grandson	*liar*	*labourer*	*future teller*	*disabled*
RIPOSATO	FIDANZATA	POMPIERE	AVVENENTE	AIUTANTE
rested	*fiancée*	*fire-fighter*	*attractive*	*helper*
AMMALATO	COMPAGNA	SERGENTE	SENSUALE	PROMOTER
sick	*partner*	*sergeant*	*sensual*	*promoter*
LAUREATO	RAGAZZINA	GANGSTER	SEDUCENTE	CREDENTE
graduated	*young girl*	*gangster*	*seductive*	*believer*
STUDIOSO	FORTUNATA	MERCANTE	ATTRAENTE	ADERENTE
studious	*fortunate*	*merchant*	*attractive*	*supporter*
PROMOSSO	NEONATA	MANDANTE	FRAGILE	GENITORE
promoted	*new-born*	*'person who sends someone to commit a crime'*	*fragile*	*parent*
COSTIPATO	SCOLARA	WEBMASTER	BADANTE	COMPLICE
sick	*scholar*	*webmaster*	*caregiver*	*accomplice*
FIGLIOLO	ASMATICA	PIROMANE	PEDICURE	CANTANTE
son	*asthmatic*	*pyromaniac*	*pedicurist*	*singer*
POVERELLO	CONTATTATA	SOMMELIER	CHIROMANTE	FIGURANTE
poor (person)	*contacted*	*wine steward*	*palmist*	*walk-on actor*
GUARITO	IMPEGNATA	PASTORE	AMOREVOLE	PENDOLARE
recovered	*busy*	*minister*	*loving*	*commuter*

Grammatical		**Stereotypical**		**Fillers**
masculine	**feminine**	**masculine**	**feminine**	
INESPERTO	STRANIERA	FALEGNAME	PETULANTE	OFFERENTE
non-expert	*foreigner*	*carpenter*	*annoying*	*offerer*
PAESANO	ASSONNATA	SKIPPER	PORNOSTAR	INDECENTE
villager	*sleepy*	*skipper*	*porno star*	*lewd*
INQUILINO	ASCOLTATA	CORRIDORE	ECCITANTE	MINORENNE
tenant	*listened to (person)*	*runner*	*exciting (person)*	*under-age*
AFFILIATO	RELIGIOSA	INGEGNERE	SENSIBILE	ASPIRANTE
affiliated	*religious*	*engineer*	*sensitive*	*aspirant*
DOTTORANDO	INDISPOSTA	CONDUCENTE	BABYSITTER	RESIDENTE
PhD student	*sick*	*driver*	*babysitter*	*resident*
PARANOICO	ANTIPATICA	NAVIGANTE	CARTOMANTE	FAMILIARE
paranoiac	*unpleasant*	*sailor*	*fortune-teller*	*familiar*
PENSIONATO	ECCENTRICA	BRACCIANTE	PROVOCANTE	CONOSCENTE
pensioner	*eccentric*	*labourer*	*provocative*	*acquaintance*
INTROVERSO	RICOVERATA	MENDICANTE	CONFIDENTE	INTERINALE
introvert	*hospitalized*	*beggar*	*confident*	*interim*
SVEGLIATO	TRASFERITA	AMBULANTE	DEBUTTANTE	CONVIVENTE
awoken	*moved*	*street vendor*	*debutante*	*co-habiting*
SMEMORATO	PASSEGGERA	INVENTORE	INSEGNANTE	RICEVENTE
forgetful	*passenger*	*inventor*	*teacher*	*recipient*

	Stereotypical		Grammatical		
	feminine	masculine	feminine	masculine	
Log frequency	2.8 (0–4.6)[1]	2.9 (1.1–4.8)	2.9 (1.5–4.4)	2.9 (0.8–4.7)	*p*>.05
	0.9	*0.7*	*0.8*	*0.7*	
Length	8.0 (4–10)	7.8 (5–10)	8.0 (4–10)	7.8 (5–10)	*p*>.05
	1.8	*1.4*	*1.8*	*1.4*	
Stereotypicality	5.3 (4.6–6.5)	2.4 (1.7–3.1)	4.0 (3.8–4.2)	4.0 (3.8–4.2)	
(raw ratings)	*0.6*	*0.4*	*0.1*	*0.1*	
Stereotypicality	2.7 (1.5–3.4)*	2.4 (1.7–3.1)*	4.0 (3.8–4.2)**	4.0 (3.8–4.2)**	**p*>.05
(normalized)[2]	*0.6*	*0.4*	*0.1*	*0.1*	***p*>.05
Valence	4.5 (2.3–6.1)	4.2 (1.7–5.6)	4.2 (1.7–6.3)	4.3 (2.2–5.6)	*p*>.05
	1.1	*1.0*	*1.2*	*1.1*	

[1]Min and max ratings are indicated in parenthesis. Standard Deviation is indicated in italics below the means. T-tests were performed on the means; no statistically significant differences were found in any of the comparisons, suggesting that the stimuli were closely matched for the above properties.
[2]The final rating assigned to each word was calculated by combining the ratings obtained with both directions of the rating scale.