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Neural correlates of automatic beliefs about gender stereotypes: Males are more prejudicial

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ABSTRACT

Aim of this study was to investigate the neural bases of stereotype representation, including the presence of gender bias. EEG was recorded from 128 sites in 38 Italian participants. While looking for rare animal words, participants read 240 sentences, half of which expressed notions congruent with gender stereotypes, and the other half did not (e.g., "Prepared the tomato sauce and then SHAVED", "The engineer stained HER SKIRT"). Event-related potentials (ERPs) were time-locked to critical words. Findings showed enhanced anterior N400 and occipito-parietal P600 responses to items that violated gender stereotypes, mostly in men. The swLORETA analysis applied to N400 potentials in response to incongruent phrases showed that the most activated areas during stereotype processing were the right medial temporal and medial frontal gyri, as well as the TPJ. The data hint at a gender difference in stereotyping, with men being more prejudicial especially when the depicted character is a male.

1. Introduction

The aim of this study was to investigate the neural correlates of the representation of social information, and, in particular, the occupational gender stereotypes in which women engage more in care-related professions and men in strength/power related professions. The time course and the neural correlates involved in the representation of occupational gender biases were investigated by addressing two questions: first, if the biases varied as a function of participant's sex; and second, if there was a difference based on the gender of the character depicted in the phrases. An implicit paradigm was chosen to trigger the automatic activation of any mental function involved in the processing of gender stereotypes. This was carried out by recording electrophysiological responses in young heterosexual Italian university students during the reading of hundreds of sentences depicting female and male characters and their professional attitudes. The task consisted of responding to animal words, in order to avoid explicit social desirability processes, and the brain responses of male and female participants totally unaware of study's purpose were compared. The implicit nature of the task provides a significant benefit in comparison to explicit tasks commonly used in the previous literature on gender stereotypes (e.g., see the nice and updated collection of papers in Garnham, Oakhill, Sczesny, & Von Stockhausen, 2016, as well as Molinaro, Su, & Carreiras, 2016; Fabre, Causse, Pesciarelli, & Cacciari, 2015; Osterout et al., 1997; White, Crites, Taylor, & Corral, 2009). Indeed, moral instances, for example the believe that "women should be engineers too!" may interfere with decisional processes, thus masking semantic or pragmatic effects in task requiring to establish sentence correctness. A clear example is provided by Canal, Garnham, & Oakhill's (2015) investigation in which they recorded Event-Related Potentials (ERPs) to investigate differences in the use of gender information during the processing of reflexive pronouns. Pronouns (e.g. him, her) either matched or not the gender provided by role nouns (such as "king" or "engineer") and participants were explicitly asked to judge their acceptability in terms of grammar and meaning. The explicit nature of the task requirements likely engaged voluntary control and moral decisions; indeed the authors of the study themselves report that "participants were instructed to base their ratings on how the world is and not how it ought to be", corresponding to a request of suppressing possibly moral instances. Again, in White et al.'s (2009) study participants were primed with either the gender category 'Women' or 'Men', followed by a word which was either consistent with gender stereotypes (e.g. Women: Nurturing) or inconsistent (e.g. Women: Aggressive). They were explicitly asked to indicate whether the words matched or did not match, according to gender stereotypes. Both response times and event-related brain potentials (ERPs) were recorded during performance of the task. As predicted, stereotype incongruent word pairs were associated with larger N400 ERP amplitudes and slower response times, relative to congruent

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word pairs. Both studies did not shown a sex bias in stereotype representation.

An implicit task was instead used in a previous electrophysiological investigation (Proverbio, Orlandi & Bianchi, 2017), in which however the sex of participants was not considered. The data showed that a violation of the current stereotype in a terminal word paradigm, as in the sentence "Prepared the tomato sauce and then SHAVED" as compared to a congruent sentence such as "Fed the little girl and went to the LADY-HAIRDRESSER", elicited a N400-like anterior negativity in the 350–450-ms temporal window followed by a later anterior negativity (LAN). These findings suggest that gender stereotypes are processed automatically (as if they were morpho-syntactic errors) and hints at how they are deeply rooted in our linguistic brain. According to the source reconstruction performed on the N400 responses, the neural representations of gender-based stereotypes mostly involved the middle frontal gyrus, which is compatible with available literature (e.g., Fourie, Thomas, Amodio, Warton, & Meintjes, 2014; Knutson, Mah, Manly, & Grafman, 2007; Proverbio, La Mastra, & Zani, 2016; Mitchell, Macrae, & Banaji, 2006; Mahy, Moses, & Pfeifer, 2014); the temporo/parietal junction (supposedly supporting theory of mind (TOM) processes according to Saxe, Moran, Scholz, & Gabrieli, 2006; Saxe, 2010); and the superior and middle temporal gyri, representing person information (e.g., Freeman, Schiller, Rule, & Ambady, 2010; Ibañez & Manes, 2012; Quadflieg et al., 2009).

Because these stereotypes are a part of everybody's cultural heritage and learned early in life, people form implicit gender stereotypes, which automatically associate men and women with stereotypical traits, abilities, and roles, even when they disavow these traditional beliefs (e.g., Nosek, Banaji, & Greenwald, 2002). For instance, women are typically stereotyped as being nicer (Eagly & Mladinic, 1989) and are more likely to enact subordinate roles that require communal traits. The presence of gender stereotyping has been demonstrated for an extensive list of role nouns in Czech, English, French, German, Italian, Norwegian, and Slovak by Misersky et al. (2014). With the help of a reaction-time-based measure of implicit cognition that is the Implicit Association Test (Greenwald, McGhee, & Schwartz, 1998), gender stereotypes that consist of associating agency to men and communality to women have been demonstrated at the implicit level (e.g., Rudman & Glick, 2001). Strong gender implicit stereotypes have also been observed among the Italian population at all age ranges, including elderly individuals and children as a young as 8 years old (Cacciari & Padovani, 2007; Siyanova-Chanturia, Warren, Pesciarelli, & Cacciari, 2015). These stereotypes have also been translated into a gender-career implicit stereotypes, with men more strongly associated with careers and women more strongly associated with family (Nosek et al., 2002). In an interesting neuropsychological study (Milne & Grafman, 2001), patients with prefrontal cortex lesions and controls were administered an IAT that measured the degree of implicit associations between male and female names and attributes of strength and weakness. The results showed that while controls manifested strong stereotypical associations (i.e., stronger associations between male names and strength attributes and between female names and weakness attributes than those between males and weakness and females and strength), patients with ventromedial prefrontal cortex lesions showed significantly lower associations, thus suggesting a role for this region in representing social knowledge. A similar finding was described by Gozzi, Raymont, Solomon, Koenigs, and Grafman (2009) in patients with a lesion in the ventrolateral prefrontal cortex (vlPFC), showing a reduction of the gender stereotype in which female names (e.g., Mary) are usually more associated with "fragile" and "delicate" than with "dominant" and "powerful" attributes (and vice versa). Accordingly, Cattaneo, Mattavelli, Platania, and Papagno (2011) using the same strength/weakness IAT paradigm and found that applying TMS over the left dorsolateral PFC and the right anterior dorsomedial prefrontal cortex (aDMPFC) increased the gender-stereotypical bias in male participants compared to when TMS was applied to a control site (vertex).

Interestingly, in that study, women did not show a significant gender bias on the IAT, and, correspondingly, their responses were unaffected by TMS. A gender stereotype confined to males only was also reported by Cikara et al.'s fMRI study (2011) in which male (but not female) participants with higher hostile sexism scores more quickly associated sexualized women with objectifying verbs such as "handle" (and clothed women with third-person action verbs such as "handles") than the inverse, compared to their less sexist peers. Furthermore, hostile sexism correlated with activation of regions associated with mental state attributions, such as the medial prefrontal cortex, posterior cingulate and temporal poles.

Whether social attributes are more gender-biased in male than female participants has seldom been investigated with electrophysiological techniques. For example, the ERP study by Leynes, Crawford, Radebaugh, and Taranto (2013) provided evidence that gender stereotypes affected a late ERP memory component by enhancing recollection, but no sex analysis was performed. Again, in the ERP study by White et al. (2009), participants made quicker judgments for stereotypically congruent prime–target word pairs (Women: Nurturing) than to incongruent word pairs (Men: Nurturing). This incongruence effect led to larger N400 amplitudes in response to incongruent word pairs vs. congruent word pairs, but no gender effect was investigated.

Other studies on gender stereotypes (e.g., Canal et al., 2015) have found a modulation of the later positive P600 complex or SPS (Syntactic Positive Shift), which is supposed to reflect the costs of repair and reinterpretation of phrase structural mismatches and/or higher order integration processes (Martin-Loeches, Nigbur, Casado, Hohlfeld, & Sommer, 2006; Friederici, 2002). In detail, in Osterhout et al.'s study (1997), ERPs were recorded while 14 males and 14 females read sentences containing a reflexive pronoun that referred to a definitionally or stereotypically male or female antecedent noun. Pronouns that disagreed with the gender definition or gender stereotype of the antecedent elicited a large-amplitude P600. In sentences such as "The doctor prepared herself for the operation", the pronoun herself was perceived as anomalous due to the stereotype that the medical profession is purely male. Instead, in the sentence "The nurse prepares herself for the operation" the pronoun agreed with the shared stereotypes that the nurse is a more feminine profession. Pronouns violating stereotypes triggered a large positive wave that corresponded to the P600. It is interesting to note that female participants showed larger P600 components than males, but this effect was independent of the inconsistency condition.

In a behavioral study, Cacciari and Padovani (2007) found that when the gender stereotype conveyed by a role noun acting as a prime stereotypically female-oriented, an inhibition effect emerged in the response times to a gender- incongruent pronoun (e.g., teacher – he). In contrast, compared to the control condition, no inhibition emerged when participants were presented with a masculine role noun followed by an incongruent pronoun (e.g., engineer – she). In Siyanova-Chanturia, Pesciarelli, & Cacciari (2012) gender stereotypes affected the brain response to masculine and feminine pronouns differently: participants were more accepting of female drivers than male teachers suggesting that gender stereotypes – conveyed by occupation nouns or personal traits – might be more restrictive for females than males. They found a larger N400 in response to masculine pronouns preceded by incongruent definitional or stereotypical primes (e.g., "he" preceded by either (female) *passenger* or *teacher*) or in response to feminine pronouns preceded by incongruent definitional primes (e.g., "she" preceded by (masculine) *retired*) but, interestingly, not by incongruent stereotypical primes (e.g., "she" preceded by *driver*).

In conclusion, the effect of gender on occupational stereotypes has failed to show a uniform pattern of results across different studies, probably also because of the use of explicit tasks requiring to openly judge the correct associations between genders and gender-biased professions. For example, Osterhout, Bersick, and McLaughlin (1997) found that gender violations elicited larger P600 responses for female