

ELECTROPHYSIOLOGICAL MARKERS OF PREJUDICE RELATED TO SEXUAL GENDER

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Abstract—Previous studies have shown that Event-related potentials (ERPs) are sensitive to violations of gender-based stereotypes. In the present investigation, we used ERPs to measure the detection of a discrepancy between gender-based occupational stereotypes and written material presented to fifteen Italian viewers in a completely implicit task. No awareness or judgment about stereotypes was required, no decision had to be made on sentence acceptability or congruence, and no prime words related to gender were presented (which might reveal the matter of the investigation). EEG was recorded while participants engaged in a task that consisted of pressing a key in response to animal words, while ignoring the overall study's purpose. Two hundred forty sentences that did or did not violate gender stereotypes were presented randomly with 32 other sentences ending with an animal word. Terminal words violating gender stereotypes (such as “*The notary is BREASTFEEDING*” or “*Here is the commissioner with HER HUSBAND*”) elicited a greater anterior N400 response and left anterior negativity (LAN) than words conforming to the gender stereotype (e.g., “*The chemist put on a nice TIE*”). LAN modulation suggests 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 inverse solution, the neural representation of gender-based stereotypes mostly involved the middle frontal gyrus (MFG). The temporo/parietal junction (TPJ) supporting theory of mind (TOM) processes was also engaged, along with the superior and middle temporal gyri representing person information. © 2017 IBRO. Published by Elsevier Ltd. All rights reserved.

Key words: ERPs, prejudice, social cognition, TOM, N400, world knowledge.

INTRODUCTION

The aim of this study was to investigate the temporal and neuro-anatomical functional correlates of processes related to the representation of prejudices by means of EEG/ERPs and source reconstruction techniques. In particular, the object of investigation was gender

prejudice, which is a series of stereotypes associated with typical male or female appropriate or common behaviors, attitudes, clothing, jobs, personality traits, abilities, and others. This information refers to the so-called world knowledge shared by a given social group, and can be investigated by means of ERP measures (Ibáñez et al., 2009; Amodio et al., 2013; Hagoort and van Berkum, 2007; Metzner et al., 2015) as demonstrated for example by Hagoort et al. (2004) in their seminal study. They found that a violation of common knowledge (for example the color of trains in Holland) elicited a N400 component similar to the semantic N400 found for violations of semantic relatedness or congruence in the neuro-linguistic literature (Kutas and Hillyard, 1980, 1984; Kutas and Federmeier, 2011; Hald et al., 2007; Lau et al., 2008). The N400 has also been found to be affected by personal semantics (Coronel and Federmeier, 2016), that is by violations relative to subjective knowledge (i.e., personal preferences (likes and dislikes) across a wide range of topics, including foods, sport teams, music, films, etc.) or by action plausibility (Proverbio and Riva, 2009). As for the Italian language, several ERP studies have provided evidence of a N400 modulation for semantic (or syntactic) incongruities (see Angrilli et al., 2002). For example Proverbio et al. (2009) presented pairs of common or proper names' words that could be semantically related (“Woody Allen” or “social security”), or not (“Sigmund Parodi” or “judicial cream”) and they found much larger N400s to unrelated than related items. Again N400 responses were obtained both for Slovenian and Italian semantically incongruent terminal words (e.g., “La struttura della città era troppo invidiosa” –The structure of the city was too envious– or “Polglasno petje jo je privolilo”) in the bilingual brain of Italian/Slovenian speakers (Proverbio et al., 2002), with an effect of language age of acquisition (that is L1 vs. L2) but no effect of language (Italian vs. Slovenian) per se.

A few studies have used the N400 response as an index to investigate the neural representation of stereotypes (Bartholow et al., 2001, 2003). Osterhout et al. (1997) showed participants sentences referring to stereotypically male or female occupations and pronouns that did or did not match the gender stereotypically implied by the job (for example, “The beautician put herself through school” vs. “The beautician put himself through school”). They found increased N400 responses in association with the prejudice violation.

Whereas gender prejudice has been rarely investigated from a neuroscientific point of view or with

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ERPs, racial bias has been much more commonly studied (e.g., see the famous other-race effects found for face processing (Hart et al., 2000; Caldara et al., 2003; Ronquillo et al., 2007) or empathy for pain (Contreras-Huerta et al., 2013). For example, Hehman et al. (2014) recorded ERPs in a sequential priming task in which positive or negative stereotypes related to black (African-American) or white (Caucasian) people followed the presentation of either black or white faces acting as primes. The results showed that the N400 was larger in the trials in which the face prime was incongruent with the target trait compared to trials in which the face prime was congruent with the target trait. In Correll et al. (2006)'s study, subjects were required to make a quick shoot/don't-shoot decision in response to armed or unarmed characters, half of whom were Caucasian as opposed to Black. Self-reported measures of cultural stereotypes predicted both the racial ERP differentiation and racial bias in the game. The degree of ethnic differentiation in the P200 and N200 amplitude predicted behavioral bias in the videogame and correlated with explicit measures of race-based cultural stereotypes. With a similar N400 paradigm, the prejudice of Chinese city residents against rural migrant workers was tested (Wang et al., 2010). For example, in this study, the positive adjective "clean" preceded by a prime related to rural migrants elicited a larger N400 than the negative adjective "dirty", as it violated their social representation.

Several neuroimaging studies suggest that in addition to the amygdala, there is a crucial area of the brain that plays a key role in the formation of the prejudices: the medial prefrontal cortex (mPFC). It has been observed, for example, that judging a person based on his/her political views in the absence of other information, or considering a person solely on the basis of ethnicity or gender stereotypically, is accompanied by increased activity of the mPFC (Mitchell et al., 2006). Accordingly, lesions of the medial prefrontal cortex are associated with a decrease of a whole series of implicit beliefs that produce gender bias (Milne and Grafman, 2001). These findings suggest, therefore, that the mPFC plays an important role in the generation of prejudices and stereotypes.

Quadflieg et al. (2009) investigated the neural bases of gender prejudice by means of fMRI. Bold signals were obtained while subjects made judgments about the likely person or location of a series of activities, some of which were associated with a specific gender stereotype. The data showed that stereotyping was associated with enhanced activity in the ventral mPFC and in the amygdala among other areas. Notably, brain activity associated with stereotypic judgments was correlated with the strength of participants' explicit and implicit gender stereotypes.

Freeman et al. (2010) used functional magnetic resonance imaging to dissociate the neural mechanisms underlying social judgments and found that BOLD activity in the anterior medial prefrontal cortex was reduced when participants were thinking about a person that did not belong to their social group (out-group), such as drug addicts, homeless people or people of non-white racial origins, compared to when they thought about in-group individuals.

Another region that seems to be strongly involved in the representation of negative bias or prejudice is the precuneus. Bruneau and Saxe (2010) presented Arabic, Israeli and American individuals with sentences about the Middle East situation from an in-group vs. an out-group perspective. Participants were required to rate how reasonable they found the statements while fMRI data were obtained. They found an enhanced activation of the precuneus while reading pro-outgroup compared to reading pro-ingroup sentences, and this increased activation strongly correlated with both explicit and implicit measures of a negative prejudice toward individuals belonging to other ethnic groups.

As for gender stereotypes, White et al. (2009) used an explicit paradigm in which words related to gender (e.g., 'Women' or 'Men') were followed by a word that was either consistent or inconsistent with gender stereotypes (e.g., "Women: Nurturing vs. Aggressive"). Participants were required to decide whether the words matched based on gender stereotypes. Stereotype-incongruent word pairs resulted in greater N400 responses and slower reaction times as compared to congruent word pairs.

One of the possible problems with these paradigms is that subjects are aware of the object of the study or the manipulation because they are explicitly primed with 'Women' or 'Men' types of words and asked to access their gender stereotypes to make decision. This issue has only been partially avoided in other studies on gender stereotypes (e.g., Osterhout et al., 1997). If ERPs are recorded to reflexive pronouns that referred to a stereotypically male or female antecedent noun and if there were no sex-based primes, participants are still asked to consciously make a decision about the sentence acceptability, which might involve bias inhibition or negation processes linked to social desirability.

This study is the first study, to the best of our knowledge, in which sexual prejudice neural representation was investigated without requiring the participants' awareness or judgment. No decision had to be made whatsoever on the sentence acceptability or congruence, and no words related to gender were presented (which might reveal the object of the investigation). Brain activation was observed while participants engaged in an animal word detection task, which completely ignored the study's purpose. An implicit task was used to elicit automatic activation of subjective and unexpressed information related to gender occupational biases.

Independent implicit measures of strong gender prejudice have been created for the Italian population through all age ranges, including elderly individuals and children as young as 8 years old (Sivanova-Chanturia et al., 2015).

On the basis of previous evidence in the literature, it was expected that we would find an enhanced N400 response to prejudice violations. Indeed, other electrophysiological studies investigating the neural representation of gender or racial prejudice have clearly determined the effect of prejudice violation on the amplitude of the N400 component. One of the main differences between the other studies and the present

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