Electrophysiological Correlates of Social Group Representations in Affective Priming

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Abstract

There is growing evidence in cognitive neuroscience that, compared with processing information about nonsocial semantic categories, processing information about social groups involves to a greater extent the associated affective features. With the present study we aimed at assessing the extent of such involvement by measuring event-related potentials in healthy individuals while they performed an affective priming paradigm requiring evaluative responses. Behavioural results showed a greater affective priming for social group than for nonsocial category targets, while the analysis of the neural correlates revealed a modulation in a late positive component, which was higher in the positive valence social groups as compared to positive valence nonsocial categories. The present findings complement previous neuropsychological and brain stimulation studies by showing how the engagement in affective processing enhances the representation of social groups compared to nonsocial categories, as indicated by the emergence of a distinct behavioural and neurophysiological response.

Introduction

When we categorise our conspecifics into social groups according to characteristics such as gender, ethnicity, social status or occupation, we rely on both semantic and affective information. For example, the label “criminals”, referred to people being guilty of crimes, is generally associated with its negative evaluation; likewise, the label “students”, in addition to informing us about the young age of individuals that attend some type of educational programme, would generally be attached to a positive evaluation. The semantic component informs us about the appearance and behaviour of the group, whereas the affective one determines our attitude, a positive or negative disposition towards it (Wilson, Lindsey, & Schooler, 2000). The semantic and affective systems have often been regarded as being apart (Pessoa, 2008), however arguments in support of their interdependence have also been put forward. For instance, it has been suggested that the affective information would be a core component of our conceptual knowledge as much as any other type of information, and that its relevance would differ depending on the semantic category (Barsalou, 2008; Lambon Ralph, Jefferies, Patterson, & Rogers, 2016). In particular, some authors have proposed that affective information largely contributes towards the representation of conspecifics (Lambon Ralph et al., 2016; Mahon & Caramazza, 2011; Martin, 2016). Indeed, neuropsychological studies documented patients with a selective deficit at processing social groups, thus suggesting that concepts about them might have a representation of their own (Carnaghi, Silveri, & Rumiati, 2015; Rumiati, Carnaghi, Imbrota, Diez, & Silveri, 2014). Moreover, widespread tumour lesions in areas commonly linked to affective processes affected the patients’ accuracy at naming pictures of social groups (Piretti et al., 2015). What is still poorly understood is the role played by valence in processing the affective information about social groups. Using transcranial magnetic stimulation on healthy subjects, an increased excitability of the inferior frontal gyrus, previously associated to the processing of negative valence stimuli, has been found to facilitate the categorization of negative social groups (Suran, Rumiati, & Piretti, 2019).

To further assess the extent to which affective valence contributes to the semantic representation of social groups, we employed an affective priming paradigm (Fazio, 2001; Fazio, Sanbonmatsu, Powell, & Kardes, 1986). During the test, participants are shown either a positive or negative target word upon which they build an evaluative response. To influence their speed in evaluating the target, a prime word of the same or opposite valence is presented right before its appearance. The priming effect corresponds to faster responses to targets preceded by affectively congruent, relative to affectively incongruent primes. Using the effect as a proxy for the reliance of a target category on affective features, if such reliance is greater for social categories, we expect affective priming to be greater for social categories relative to objects, or nonsocial categories in general.

When pairing the affective priming procedure with an evaluative task, two mechanisms are thought to contribute to the resulting priming effect the most (Herring et al., 2013). A first mechanism is regarded to stem from a spreading of activation in the affective/semantic network (De Houwer & Randell, 2002; Fazio, 2001; Spruyt, Hermans, Houwer, & Eelen, 2002), for which a faster evaluative response is the result of a facilitated encoding of the target following an affectively congruent prime. A second account argues that, given that the prime can also be evaluated using one of the response buttons, a greater response readiness to press the same button is present the moment the congruent target appears, resulting in a shorter reaction time relative to the incongruent condition (Klauer & Musch, 2003). In the present case, in the absence of any difference in the overall evaluative response times, we argue that the expected categorical difference in the priming effect would be better explained by the encoding account. If subjects are overall equally fast at evaluating both target categories, the presence of a greater priming effect for social categories would be indicative of a greater susceptibility to an affect-driven encoding facilitation, stemming from the exposure to the same primes.

To establish the stage at which the primes influence the processing of the targets, we complemented the behavioural paradigm with the measurement of event-related potentials (ERPs). The two most studied components in affective priming are the N400 (~400 ms post-target onset) and the late positive component (LPC; ~600 ms post-target onset), whose effects emerge from their differences between congruent and incongruent trials. In this context, the former effect has been associated with the process of integrating the semantic content of primes and targets (Zhang, Lawson, Guo, & Jiang, 2006; Zhang, Li, Gold, & Jiang, 2010). The LPC, reported to be sensitive to word valence (for a review, see Citron, 2012), has been regarded to also capture affective prime-target incongruities and thus to be a more reliable index of affective priming when controlling for non-affective prime-target relationships (Herring, Taylor, White, & Crites, 2011; Hinojosa, Carretié, Méndez-Bértolo, Míguez, & Pozo, 2009).

In line with previous studies showing a facilitated response to manipulable object targets following sensory-motor priming (Labeye, Oker, Badard, & Versace, 2008; Myung, Blumstein, & Sedivy, 2006), at the behavioural level we expected that activating the processing of affective information would result in a facilitated response (i.e. shorter reaction times) to social groups. Moreover, such affect-driven facilitation, if not specific to social groups, was expected to be significantly greater when compared to the facilitation observed for non-social semantic categories. As there is yet no consensus concerning which ERP component should be more sensitive to affective priming, we expected to find both an N400 (Zhang et al., 2006, 2010) and an LPC effect (Herring et al., 2011). Additionally, as for the behavioural counterpart, we expected these effects to be greater towards social category targets relative to nonsocial categories, reflecting their hypothesized greater reliance on the affective features being primed.

Methods

Participants

Twenty-six healthy right-handed participants, all Italian native speakers, were recruited from the local population in exchange of monetary compensation, all giving written consent prior to participation. Because of the failure to obtain enough EEG data in three participants due to the presence of artefacts coming from excessive movement, these were excluded from the analysis, bringing the final sample to 23 participants (13 female, age range 19-29). Sample size estimation was conducted using the G*Power software (Faul, Erdfelder, Lang, & Buchner, 2007). A sample size of at least 20 participants was suggested for a within-subjects design with two repetitions in a repeated-measures ANOVA expecting a medium-to-large affective priming effect size (Cohen, 1988) in an evaluative task ($d = .67$; De Houwer, Hermans, Rothermund, & Wentura, 2002), with a power ($1-\beta$) of .8. The study was approved by the SISSA Ethics Committee in accordance with the Declaration of Helsinki.

Materials

A total of 108 plural nouns of social categories ($N = 54$) and nonsocial categories ($N = 54$) were used as target stimuli after being selected from a larger database rated by a different sample of 12 subjects. Each semantic category was divided in a positive and negative subset of 27 elements each (see Supplementary Table 1), differing significantly in their valence ratings [Social positive vs. Social negative, $t(52) = 20.66, p < .001$; Nonsocial positive vs. Nonsocial negative, $t(52) = 22.24, p < .001$]. Additionally, within each valence subset, social and nonsocial category nouns were matched according to their average ratings of valence, arousal, familiarity, and length (see Supplementary Table 2 and 3). A separate sample of 18 words to be used as primes was obtained from the ANEW rated database of Italian words (Montefinese, Ambrosini, Fairfield, & Mammarella, 2014). These represented neither social nor nonsocial categories and consisted of 9 positive and 9 negative words (see Supplementary Table 3) which differed significantly in their valence [$t(18) = 33.23, p < .001$], and matched according to their arousal [$t(18) = .28, p = .78$], familiarity [$t(18) = .02, p = .98$], length

$[t(18) = .86, p = .40]$, concreteness $[t(18) = .24, p = .81]$. The additional concreteness matching was done to account for the different effects of abstract and concrete prime words on affective priming (Yao & Wang, 2013). To this list of words, 9 strings of hash symbols (#) with an equal average length to the positive and negative words (5-8 elements) was added to serve as affectively neutral primes, bringing the total number of primes to 27.

To ensure a semantic relationship of equal magnitude between the prime words and each target Category/Valence group, we employed the Italian version of the *snaut* open online software (<http://meshugga.ugent.be/snaut-italian-2/>) to extract their respective semantic distances, calculated based on word co-occurrences in large text corpora via cosine similarities between semantic vectors (Mandera, Keuleers, & Brysbaert, 2017). A mixed ANOVA on the extracted values using Category and Valence as between factors and Congruence as within factor showed, as expected, a significant main effect of Congruence [$F(1, 104) = 104.9, p < .001, \eta_p^2 = .50$] characterized by a lower semantic distance for Congruent relative to Incongruent primes, and an interaction between Congruence and Valence [$F(1, 104) = 13.05, p < .001, \eta_p^2 = .11$] with a greater distance between congruent and incongruent primes for negative, relative to positive words.

Category	N	Valence	Arousal	Familiarity	Length	Semantic distance Δ
Social Positive	27	6.24 (.48)	4.11 (.42)	4.02 (1.11)	7.19 (1.24)	.03 (.04)
Nonsocial Positive	27	6.41 (.45)	3.90 (.56)	3.94 (1.13)	6.82 (1.52)	.03 (.04)
Social Negative	27	3.06 (.64)	3.93 (.50)	3.10 (.88)	7.30 (1.54)	.05 (.05)
Nonsocial Negative	27	3.28 (.58)	3.73 (.48)	2.81 (.86)	7.00 (1.52)	.06 (.04)

Table 1. Mean valence, arousal and familiarity ratings (0 = extremely low; 7 = extremely high), average word length, and difference in the semantic distance (cosine) with the congruent and incongruent primes for each target word category separated by valence class. Standard deviations reported within parentheses.

Procedure

Participants performed the affective priming task in a dark and acoustically insulated room. The task required to evaluate a target word preceded by a prime of the same or opposite valence. Instructions were provided to the participants in both written and oral form by the experimenter. Prior to the task proper, participants completed a set of 20 practice trials containing a different set of primes and targets. To ensure the task had been understood, participants had to undergo 20 additional practice trials in a newly randomised order if they had responded incorrectly to more than practice five trials. Each trial began with the presentation of a fixation cross (500 ms), after a 200 ms interval, the prime (150 ms) and the target (300 ms) appeared, separated by a 100 ms ISI (see Figure 1). After the offset of the target, participants were presented with a blank screen during which they had an additional 1500 ms to give their evaluation via button press. Following this period, or after pressing a button, the blank-screen intertrial interval was jittered between 800 and 1200 ms (in 100 ms intervals). To respond, participants pressed either the “f” or the “j” key on a QWERTY keyboard, with “positive” and “negative” response mapping counterbalanced across participants. Key-choice was driven by the presence of dash-like bumps allowing for easier identification in the dark room. To help participants differentiate primes from targets, the primes were always presented in uppercase and targets in lowercase format. Additionally, to ensure words with equal length subsided an equal amount of visual angle, all word stimuli were presented in Lucida Sans Typewriter monospaced font, thus making the amount of horizontal space occupied by each character the same.

Participants completed 324 test trials split in 12 equal blocks. The breaks between blocks were self-paced. The 108 targets were presented three times, each time paired with a prime of different valence. To avoid two same targets appearing too close to one-another, prime-target pairs were presented in a pseudo-random order. Only after all targets had been presented once in a random order, they were presented for the second time in a new order, and the same was done for the third presentation. Within each of the three resulting cycles of 108 trials, the order of the appearance of

each prime-target pair was randomised. The task was programmed in Python using the Psychopy library (Peirce, 2007), and lasted approximately 25 minutes.

Figure 1. Schematic representation of the affective priming task depicting an affectively congruent trial. Stimuli succession is represented left to right, with the respective screen presentation time expressed in milliseconds below each stimulus. The last blank display represents the intertrial interval with a jittered duration between 800 and 1200 ms in 100 ms intervals.

Behavioural data analysis

Behavioural data were pre-processed and analysed in R (R Core Team, 2016). Subjects whose overall accuracy was lower than 80% were excluded from further analyses ($n = 3$). On the remaining 20 subjects, the average accuracy score was subjected to a 2 (Category: Social vs. Nonsocial) $\times$ 2 (Valence: Positive vs. Negative) $\times$ 3 (Congruence: Congruent vs. Incongruent vs. Neutral) repeated measures ANOVA. The same model was then applied to the log-transformed RTs following the removal of incorrect trials and trials in which RTs deviated by more than 2 SD from each subject's average (14% of the total trials). As a measure of effect size we used partial eta squared. Post-hoc tests for significant higher order effects were calculated as planned contrasts on priming effects applying the Bonferroni correction.

EEG recordings and data analysis

EEG was recorded with a set of 64 Ag/AgCl active electrodes mounted on an elastic cap based on the International 10-20 system (Klem, Lüders, Jasper, & Elger, 1999). Signal amplification was achieved through a BioSemi Active-Two amplifier system. During recording data were visualised and stored by means of ActiView acquisition software (ActiView 707, BioSemi, Amsterdam, The Netherlands). Electrode offsets were kept between ± 20 mV, and the signal was sampled at a rate of 1024 Hz, with a 24-bit digitization resolution. A common mode voltage based on the ActiveTwo's CMS/DRL feedback loop was used for analog-to-digital conversion of recorded voltages for each electrode (cf. to <https://www.biosemi.com/faq/cms%26drl.htm>). Data were band-pass filtered between 0.01–100 Hz during data acquisition. To monitor eye movements and blinks, horizontal and vertical electrooculogram (EOG) was recorded via four additional electrodes placed at the outer canthi of both eyes, and below and above the left eye.

EEG data preprocessing was performed using the Brainstorm software (Tadel, Baillet, Mosher, Pantazis, & Leahy, 2011) and subsequently analysed in R (R Core Team, 2016) using the *erpR* package (Arcara & Petrova, 2014). First, the EEG recordings were resampled offline at 250 Hz and band-pass filtered (0.05 – 40 Hz). Bad electrode channels were removed upon visual inspection, as well as movement artefacts. Eye blinks artifacts were removed through independent components analysis (ICA; Makeig, Bell, Jung, & Sejnowski, 1996). Epochs containing artefacts other than eye movements were removed after visual inspection. Average ERPs were computed separately for each participant, electrode, target category/valence combination from -200 to +1500 ms relative to the onset of the target, and baseline-corrected using the 200 ms pre-stimulus period.

To identify the time windows for the N400 and the LPC components and avoid the issue of circularity in windows selection, we used the *collapsed localizer* approach (Luck & Gaspelin, 2017) and the examination of existing literature. Both for the N400 (480 – 680 ms) and the LPC (700 - 900 ms), the waves collapsed across all conditions were used. For the respective components, the time

regions surrounding the greatest peak amplitudes were selected. Four symmetrical regions of interest (ROIs; see Figure 2) were then created by averaging the amplitude of the respective electrodes selected based on a visual inspection of the scalp topography of collapsed conditions in the relevant time windows previously obtained. Each of the four ROIs represented a combination of Caudality (frontal vs. posterior) and Laterality (left vs. right).

The resulting ERPs were subjected to two 2 (Category: Social vs. Nonsocial) x 2 (Valence: positive vs. negative) x 2 (Congruence: congruent vs. incongruent) x 2 (Caudality: frontal vs. posterior) x 2 (Laterality: left vs. right) repeated measures ANOVAs, one for each component's time window. Follow-ups to significant interactions consisted of Bonferroni-corrected contrasts of priming effects. Interactions that involved spatial factors (Caudality or Laterality) were followed up within each level. The aim of our study was to assess the effects of affective congruence across categories, thus, consideration is exclusively given to the contrasts concerning the interactions between Affective Congruence and target Category. Only interactions yielding significant follow-up contrasts are reported.

Figure 2. Scalp regions used for electrode grouping for statistical analyses of event-related potentials.

Results

Behavioural results

The analysis of the RTs showed a significant main effect of Congruence [$F(2, 38) = 8.76, p < .001, \eta_p^2 = .32$] and a significant interaction between Category and Congruence [$F(2, 38) = 3.88, p = .03, \eta_p^2 = .17$]. Follow-up analyses on the Congruence effect revealed a significant difference between the Congruent and Neutral condition [$t(38) = 3.48, p < .01$], and between the Congruent and Incongruent condition [$t(38) = 3.76, p < .01$], whereas between the Incongruent and Neutral conditions there was no significant difference [$t(38) = -.30, p > .05$] (see Figure 3a). In the interaction, a significant difference between Congruent and Incongruent trials (i.e., the priming effect) was observed for Social groups [$t(38) = 4.65, p < .001$] but not for Nonsocial categories [$t(38) = 1.87, p = .38$]. This difference was significantly greater for Social groups relative to Nonsocial categories [$t(38) = -2.78, p = .05$] (see Figure 3b).

Figure 3. a) Violin plots with reaction times (ms) to target words based on the affective congruence with the preceding prime. Congruent trials are faster relative to Incongruent and Neutral trials, indicating the presence of a facilitation of the affectively congruent primes. b) Priming effect, calculated as the difference between Incongruent and Congruent trials, for Social and Nonsocial targets. Social groups showed a greater affective priming effect following the same primes. Error bars represent ± 1 SE.

ERP results

480 – 680 ms. This time interval encompassed a negative-going wave, peaking around 600 ms, interpreted by previous authors using an analogous paradigm as reflecting the N400 (Zhang et al., 2006). Although the results revealed a significant interaction between the factors of Category, Valence, and Congruence [$F(1, 19) = 6.85, p = .017, \eta_p^2 = .26$], post-hoc analyses did not show significant categorical differences based on Congruence for targets of either Valence (both $ps > .05$).

700 – 900 ms. The analysis of the later time-window also revealed a significant 3-way interaction between Category, Valence and Congruence [$F(1, 19) = 7.25, p = .01, \eta_p^2 = .28$] which in turn showed a significant interaction also with Caudality [$F(1, 19) = 6.57, p = .02, \eta_p^2 = .26$]. Post-hoc Bonferroni-corrected contrasts showed a higher LPC for Congruent as compared to Incongruent trials for Positive Social group targets in the anterior electrode clusters [$t(89) = -3.09, p = .008$], which was not significant in the posterior clusters [$t(89) = -2.21, p = .09$]. Only in the anterior electrodes, this difference between Congruent and Incongruent trials for Social group targets was also significantly greater than the one for Nonsocial targets [$t(89) = 2.70, p = .03$]. No other LPC effects were observed (all $ps > .05$). An exploratory analysis of the anterior clusters motivated by the visual inspection of the scalp distribution of the LPC effect for Social groups (see Figure 4b) has shown that a marginally significant effect over the left electrodes [$t(104) = -2.43, p = .05$], and a significant effect over the right electrodes [$t(104) = -3.50, p = .002$], leading to a significant difference between Social and Nonsocial categories only over the right anterior cluster [$t(48) = 2.87, p = .02$]. Again, no LPC effect was found for Nonsocial targets (all $ps > .05$).

Figure 4. a) Grand average ERP waveforms divided by congruent (blue lines) and incongruent trials (red lines) for social groups (left column) and nonsocial categories (right column) of positive valence (top row) and negative valence (bottom row). Only social groups of positive valence presented a significant priming effect in the LPC time window. Coloured bands represent ± 1 SE of the respective grand averages. b) Following the same disposition, topographic maps of the difference in amplitude between congruent and incongruent trials in the 700-900 ms time window for all conditions.

Discussion

Processing affective features has been proposed to contribute to the semantic representation of conspecifics at the level of social groups (Piretti et al., 2015; Rumiati et al., 2014). The present study aimed at testing this claim by assessing whether priming affective information facilitates an evaluative response towards social groups relative to nonsocial categories. To achieve this aim, we tested the hypothesis that deciding whether the name of a social group represents a positive or negative concept, compared to that of a nonsocial category name, is faster following the presentation of affectively congruent positive and negative primes. The behavioural data supported the hypothesis that participants would show a significant affective priming effect for social group names, regardless of their valence, but not for nonsocial categories. The priming effect was mostly driven by faster evaluative responses to affectively congruent targets (i.e., positive priming), compared with incongruent and neutral conditions, while no difference was observed between these two.

As to how the measured facilitation should be interpreted in terms of its underlying mechanisms, the presence of a categorical difference in the magnitude of the affective priming effect, but not in the overall reaction times, favours the facilitated target encoding account (De Houwer & Randell, 2002; Fazio, 2001; Spruyt et al., 2002) as opposed to an explanation driven by an increased motor readiness (see Klauer & Musch, 2003). We argue that the magnitude of such facilitation may be driven by the relevance of affective features in the representation of a concept, which would be greater for social groups.

As to the ERP findings, we observed a significant category- and valence-specific effect for positive social groups in the 700-900 ms time window, with congruent trials eliciting a greater positivity relative to incongruent trials in the right-frontal region. However, this finding is not in line with previous affective priming studies reporting a greater amplitude in the incongruent condition from an LPC associated with affective integration (Herring et al., 2011). To interpret this inconsistency, we suggest the scalp distribution of the effect may reflect here a different late right

frontal component. In particular, looking at the latency, the effect might indicate a sustained post-retrieval processing, previously attributed to a greater motivational relevance of emotional stimuli (Ally & Budson, 2007; Van Strien, Langeslag, Strekalova, Gootjes, & Franken, 2009). This increased processing for positive social groups may have thus been triggered by the presentation of the preceding positive primes. This claim would also be in line with previous findings suggesting that positive primes facilitate associative processes by increasing accessibility to associations (Storbeck & Clore, 2005). Social groups might thus receive a greater benefit from such increase in the affective semantic domain.

An alternative interpretation is that the difference for the social positive condition reflects a sustained negativity for incongruent trials that is mostly evident around 700-900 ms but that arises earlier (as can be seen qualitatively from Figure 4, panel A). A similar sustained negativity with similar topography has also been previously reported, although in a different context, in conditions associated with higher efforts in elaborating meanings (Bambini, Canal, Resta, & Grimaldi, 2019). Importantly, regardless the interpretation of the neural correlate, this observed effect points to a difference in the processing between social and nonsocial categories in the case of affective priming.

In line with recent studies (Herring et al., 2011), we failed to find a significant affective priming in the N400 time window. Although the congruent primes were semantically closer to the targets compared to incongruent primes, in line with the claim that the absence of a strong modulation of the semantic relationship between primes and targets does not elicit N400 effects, this difference may have indeed not been enough pronounced. This suggests that our results mostly reflect a modulation of the affective relationship between targets and primes, rather than a semantic one. The claim is also supported by the presence of a significantly greater effect for social relative to nonsocial targets, despite the two categories not differing in their semantic distance from the congruent and incongruent primes. Last, the lack of such significant effect in the N400 could also be simply related to statistical reasons. Even if an effect is true, as an N400 in affective priming may be, it is not

expected to be replicated in every experiment (Lakens & Etz, 2017). Additionally, the effect might have also been too weak to be detected if we consider the statistical power of the present study.

An additional explanation as to why we found no effect for negative social groups in both ERP components, despite the presence of a behavioural effect, could be associated to differences in familiarity between positive and negative targets. Since the target semantic category matchings were conducted within each valence, it is possible that the expected effects for negative social categories did not emerge because of the overall lower familiarity of negative nouns (see Table 1). Previous studies indeed showed that ERP effects are influenced by familiarity in priming paradigms (Voss, Lucas, & Paller, 2010). Even if this was the reason for the lack of an effect for negative social groups, the lack of an equivalent LPC effect for positive nonsocial categories still allows us to argue in favour of a greater reliance on affective features by positive social groups.

The greater influence of affective priming towards social groups could be also explained by their relatively greater ratings of abstractness. Indeed, the same claim about a greater reliance on affective features has also been attributed to more abstract words in general because of the lack of a sensory component (Kousta, Vigliocco, Vinson, Andrews, & Del Campo, 2011; Vigliocco et al., 2014). Although social groups are on average rated as relatively more abstract than objects, first, there is no indication of the presence of a direct correlation with a word's abstractness and its reliance on affective processes, and second, they do not qualify as abstract words, as they do not lack sensory properties. Indeed, social group names as concrete stimuli are also found in several studies assessing the differences between the affective processing of abstract and concrete concepts (e.g., Newcombe, Campbell, Siakaluk, & Pexman, 2012; Yao et al., 2016; Yao & Wang, 2013). Moreover, if the greater reliance on affective features would be explained by an increased abstractness, we would expect patients showing deficits for abstract concepts to also be impaired in processing social groups, and vice versa, however, we are not aware of studies examining such dissociation. To clarify this issue, we suggest that future studies should employ equally representative pictures depicting social and

nonsocial categories as target stimuli, and test whether the same differences in affective priming emerge.

In conclusion, by showing a facilitated access to the affective component of their semantic representation following affective priming, we can support the claim that representation of conspecifics relies to a greater extent on the processing of affective features (Rumiati et al., 2014). These results contribute to explaining previous findings associating the damage and stimulation of areas commonly involved in processing affective information with the specific representation of social groups (Piretti et al., 2015; Suran et al., 2019). Although the reason and the nature for such reliance is still debated (Meteyard, Cuadrado, Bahrami, & Vigliocco, 2012), we propose that the greater association with affective processing when representing social groups could derive from the repeated engagement in empathetic (Barsalou, 2008) and evaluative responses (Piretti et al., 2015) when the meaning of these concepts is acquired and rehearsed.

Conflict of Interest

The authors declare no competing financial interests.

Data accessibility

The data that support the findings of this study are openly available on the Open Science Framework at https://osf.io/rfjuh/?view_only=4290c1ee9c704c898a1f2a3a6fd385f4, reference code RFJUH.

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