SOCIAL NEUROSCIENCE
https://doi.org/10.1080/17470919.2021.1889658

RESEARCH PAPER

Enhanced N170 to outgroup faces: Perceptual novelty or prejudice?

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ABSTRACT
Habituation to ethnic ingroup members has been reported to be greater than to ethnic outgroup members. This pattern could be due to the lack of perceptive experience (familiarity) with outgroup facial morphs or, alternatively, to the prejudice held toward that outgroup. We explored this disjunctive in 71 participants, all Spanish, who were experimentally habituated to faces from their Ingroup and to faces from two unfamiliar outgroups, one for which there is low probability of prejudice in this population (Non-prejudiced Outgroup), and one for which the probability of prejudice is higher (Prejudiced Outgroup). We indexed habituation through event-related potentials, concretely as the differential amplitude of the face-sensitive N170 component from Initial to Final trials of each group. Afterward, participants completed several prejudice measures. N170 showed significant habituation to all faces, though it did not differ among groups. However, a regression analysis revealed that individual habituation to the Outgroup faces was inversely related to implicit prejudice scores. Importantly, N170 amplitudes were maximal for the Prejudiced Outgroup in both Initial and Final trials. We conclude that these effects are explained by the prejudice held toward a specific outgroup rather than perceptive experience.

ARTICLE HISTORY
Received 9 July 2020
Revised 25 January 2021
Published online 26 February 2021

KEYWORDS
Habituation; implicit prejudice; outgroup; N170; attention

Habituation is a decrease in the magnitude or the frequency of a response due to an event repetition and not to sensorial or motor fatigue (Rankin et al., 2009; Thompson & Spencer, 1966). It allows us to move our attentional resources from the repeated event to new events. In the social domain, existing data suggest that habituation to ethnic ingroup members is greater than to ethnic outgroup members. Thus, Fisher and Kotses (1973) studied skin conductance response (SCR) habituation to a white noise in participants from different ethnic groups. They found that Caucasian participants' SCR habituated slower when the experimenter belonged to an outgroup compared to when the experimenter belonged to their ingroup. In a similar vein, Hart et al. (2000) studied amygdala activation through functional magnetic resonance imaging to ingroup and outgroup faces, and found that it diminished after repetition when faces belonged to their ingroup but not when faces belonged to their outgroup. Finally, Bramwell et al. (2014) studied the habituation of the SCR when visualizing ingroup and outgroup faces, reporting faster habituation for ingroup faces compared to outgroup faces.

This difference in the habituation to ingroup and outgroup individuals may be due to two reasons. First, as Correll et al. (2017) pointed out, outgroup members are less frequently encountered and so, we have less perceptive experience with their facial morphs than with ingroup facial morphs. Indeed, habituation is greater for stimuli for which we have more perceptive experience compared to those for which we do not (Weierich et al., 2010). Second, a member of an outgroup represents a negative stimulus for people who hold prejudices toward them. Habituation is greater for neutral or positive stimuli compared to negative emotional expressions (Fischer et al., 2003; Wright et al., 2001) and negative emotional scenes (Carretié et al., 2003). Hence, in the present study, we aimed to determine if the slower habituation to an outgroup compared to the ingroup is driven by the lack of a priori perceptive

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experience or by the prejudice toward the outgroup. Additionally, we aimed to examine whether the individual differences in habituation to ingroup versus outgroup faces were related to the individual prejudice toward the latter.

With these scopes in mind, we measured habituation to faces belonging to two outgroups and their ingroup. Participants had more perceptive experience for ingroup facial morphs than for both outgroup facial morphs. A Spanish sample was submitted to a habituation sequence of Spanish faces (Ingroup) and two groups of faces to which exists a different prejudice probability in the Spanish population, i.e., North European (Non-prejudiced Outgroup) and South American (Prejudiced Outgroup) faces. This differential probability to be susceptible to prejudice may be associated with subjective beliefs related to immigration, as later explained, and was confirmed by several measures of prejudice described below. We measured the amplitude of the N170 component of event-related potentials (ERPs) for each type of face. N170 is a negative polarity component that peaks at approximately 170 ms after stimulus onset and presents a bilateral occipitotemporal distribution (Bentin et al., 1996), and has widely be shown as being face-sensitive (i.e., its amplitude is greater in response to faces than to other visual stimuli: e.g., Rossion, 2014).

Importantly, N170 has been reported to be sensitive both to habituation and ethnicity of faces. On one hand, its amplitude decreases with facial stimuli repetition, an index of habituation (Heisz et al., 2006a, 2006b; Maurer et al., 2008; Schweinberger & Neumann, 2016). Thus, we indexed habituation as the difference between the amplitude of the N170 component during the initial and final trials of each condition. On the other hand, numerous studies have shown the enhanced N170 amplitude to outgroup faces (Caharel et al., 2011; Komes et al., 2014; Montalan et al., 2013; Ran et al., 2014; Stahl et al., 2008; Walker et al., 2008). This N170 enhancement has been related to prejudice toward the outgroup. Thus, Ofan et al. (2011) found that participants with a high implicit prejudice toward an outgroup showed enhanced N170 amplitude to faces belonging to it. Other researchers have found that participants showing high quality of contact with people from the outgroup (i.e., including behaviors such as helping, advising, comforting, etc.) show reduced N170 bias to the outgroup as compared to people not showing high quality of contact (Walker et al., 2008). However, some studies fail to find N170 differences between ingroup and outgroup faces (Caldara et al., 2004, 2003; Wiese et al., 2009) or even find larger amplitudes to ingroup faces (Ito & Urland, 2005; Ratner & Amodio, 2013; in the latter case, in- and outgroups were experimentally created, rather than intrinsic/ethnical). Task requirements have been proposed as a potential explanation for this disparity. Senholzi and Ito (2013) exposed participants to ethnical ingroup and outgroup faces. Some participants had to detect the identity of faces, and others, their ethnical category. The former (identity task) showed the largest N170 amplitudes to outgroup faces, whereas the latter (category task) to ingroup faces. The authors propose that ingroup faces tend to be perceived as individualized items, whereas outgroup faces are perceived more superficially, as a "prototype". Thus, in low-demanding tasks as ethnical categorization, the processing is individualized for an ingroup and categorical for the outgroup. Instead, tasks demanding deeper and more individualized processing require an extra effort to process outgroup faces, which is reflected in an enhanced N170. However, there are studies showing greater N170 amplitudes for ethnical outgroup even when the task consists in ethnical categorization (Caharel et al., 2011; Komes et al., 2014; Montalan et al., 2013; Ran et al., 2014).

Our experimental design allowed us to explore this open issue by testing which of both factors, prejudice or familiarity, mainly explains the N170 response to ingroup and outgroup faces. If habituation of N170 to both Outgroups (Prejudiced and Non-prejudiced) similarly differed from those to the Ingroup, we would conclude that the lack of perceptive experience drives the effect. Conversely, if the habituation of N170 response differed between the Prejudiced Outgroup and both the Ingroup and the Non-prejudiced Outgroup, we would conclude that the prejudice drives the effect. We hypothesize that Prejudiced Outgroup faces will show less reduction of N170 amplitude (i.e., slower habituation) after several repetitions than Ingroup and Non-prejudiced Outgroup faces and that this differential habituation will be associated with the measures of prejudice that participants completed.

Method

Participants

Ninety-eight Psychology students from the Universidad Autónoma de Madrid (UAM) participated in this experiment, although data from only 71 (63 women, M_{age} = 19.27 years, age range: 18–35 years, *SD* = 1.46) of them could eventually be analyzed, as explained later. The UAM's Ethics Committee had approved the study. All participants were Spanish individuals with Spanish parents, reported normal or corrected-to-normal visual acuity, provided informed consent and received academic compensation for their participation.

Stimuli

Stimuli included four Ingroup, Non-prejudiced Outgroup, and Prejudiced Outgroup oval-shape cropped male faces without facial hair. In a previous study, 43 participants (40 females, M_{age} = 19.79, SD = 3.18) evaluated a pool of 30 faces from six different ethnic groups, selected according to subjective beliefs of the Spanish population (Centro de Investigaciones Sociológicas, 2014), as detailed in the Supplemental Materials. Each face was evaluated on facial expression, attractiveness, and geographical origin, as also detailed in the Supplemental Materials. Chosen faces for the present study met the following criteria: they were expressively neutral, were matched for attractiveness, and were perceived by at least 70% of the sample as pertaining to the geographical group they were supposed to belong. Given the results of this previous questionnaire, four male faces from Northwestern Europe were selected as Non-prejudiced Outgroup and four from Central-South America as Prejudiced Outgroup. The Ingroup for our sample were four male faces from Spain. Once the four final faces per condition were chosen, they were equated for luminance. Further details on stimuli selection and their luminance manipulation can also be found in the Supplemental Materials. Faces subtended 21.52° high and 14.81° wide. For half of the trials, and in a balanced way across conditions, glasses were artificially superimposed to the faces.

Procedure

First session: Habituation task

Participants completed the habituation task in an electrically shielded and sound-attenuated room, sitting at 100 cm from the screen where the faces were presented. Two Ingroup faces, two Non-prejudiced Outgroup faces, and two Prejudiced Outgroup faces were presented 100 times to each participant. Presenting two out of the four faces selected for each experimental category to each participant was necessary for a subsequent study described elsewhere (Giménez-Fernández et al., 2020), and was determined so that the total sample perceived all the faces in a balanced way (as later explained, results did not differ as a function of the eight combinations of two faces per category which were counterbalanced across participants). Thus, the whole run comprised a total of 600 trials divided into five blocks of 120 trials each, separated by rest periods. For half of the trials, and in a balanced way across conditions, glasses were artificially superimposed to the faces. To keep participants' attention toward the stimuli, we asked them to indicate, pressing a key, if the presented face was wearing glasses or not. The presentation of stimuli was randomized within each block. In order to measure habituation, valid trials among the first 50 trials (Initial trials, from now on) of each group and valid trials mong the last 50 trials (Final trials) of each group were averaged separately (further information on valid trials is provided below). Therefore, six conditions were implemented: Ingroup Initial, Non-prejudiced Outgroup Initial, Prejudiced Outgroup Initial, Ingroup Final, Non-prejudiced Outgroup Final, and Prejudiced Outgroup Final. Stimuli remained on the screen for 320 ms and the intertrial interval was 2000 ms. We asked participants to keep their gaze at the fixation dot and try not to blink when faces were presented. Figure 1 shows a schematic representation of the habituation task.

Second session: Prejudice measures

From 5 to 40 days after the first session (M = 23.00, SD = 9.31), participants completed several prejudice related questionnaires and one contact measure, described next. A more detailed description can be found in the Supplemental Materials.

Implicit Association Test (Greenwald et al., 1998). Implicit prejudice against the Non-prejudiced and the Prejudiced Outgroup was measured through two computer-based Implicit Association Tests (IAT). This test took around 7 minutes.

Affective Thermometer (Frias-Navarro, 2009). This test measures warmth toward the Non-prejudiced and the Prejudiced Outgroup. It took around one minute.

Internal and External Motivation to respond without prejudice (Plant & Devine, 1998). This test measures to which extent a person's motivation to avoid prejudiced responses is internal (e.g., personal egalitarian values) or external (e.g., social reprobation). The test took around 20 minutes to be completed.

Close contact. We measured participants' amount of close contact with each Outgroup. This test took around 5 minutes to complete.

Ad-hoc scale for Non-prejudiced and Prejudiced Outgroup. We used three items from the Spanish adaptation (Frias-Navarro, 2009) of the *Subtle and Blantant prejudice scale* (Pettigrew & Meertens, 1995) to measure the explicit prejudice toward the Non-prejudiced and the Prejudiced Outgroup. This test took approximately 5 minutes.

EEG recording and pre-processing

EEG activity was recorded during the habituation task using an electrode cap (Electro-Cap International, Eaton, OH) with tin electrodes. Fifty-nine electrodes were placed at the scalp following a homogeneous

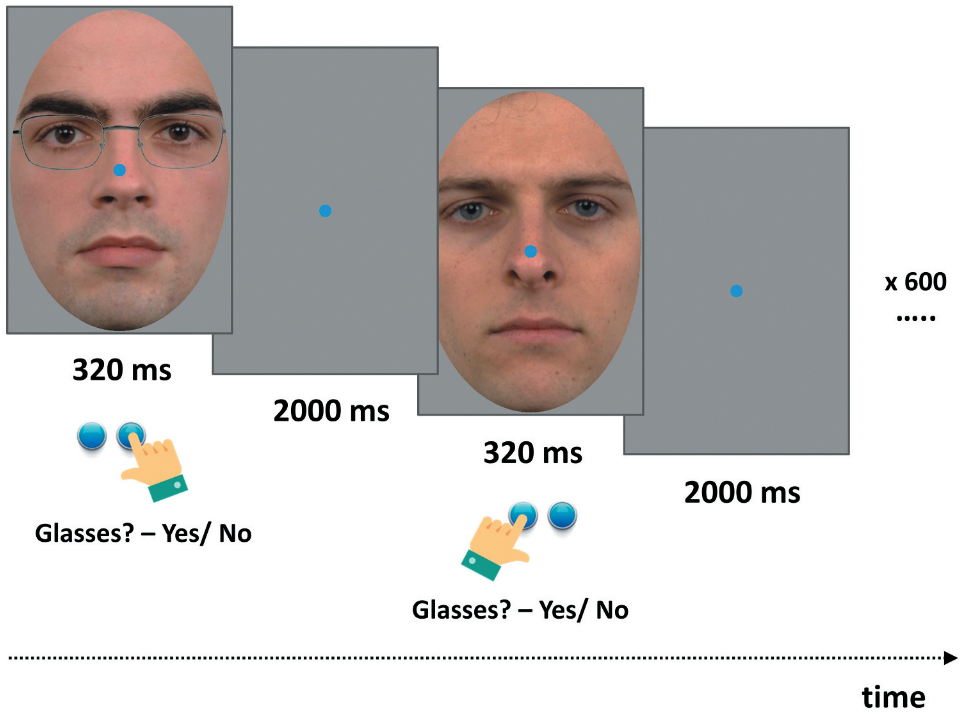

Figure 1. Schematic representation of the habituation task.

distribution and the international 10–10 system. All scalp electrodes were referenced to the nose tip. EOG data were recorded supraorbitally and infraorbitally (vertical EOG) as well as from the left versus right orbital rim (horizontal EOG). An online analog high-pass filter of 0.3 Hz was applied. Recordings were continuously digitized at a sampling rate of 420 Hz. An offline digital Butterworth bandpass filter (order: 4, direction: zero phase forward and reverse, 2-pass filter) from 0.3 to 30 Hz was applied to continuous (pre-epoched) data using Fieldtrip software (fieldtrip.fcdonders.nl; Oostenveld et al., 2011). The continuous recording was divided into 1000 ms epochs for each trial, beginning 200 ms before stimulus onset. Ocular artifact removal was carried out through a strategy based on Independent Component Analysis (Jung et al., 2000), as provided in Fieldtrip and followed by a second stage of visual inspection of the EEG data. If any further artifact was present, the corresponding epoch was discarded. This artifact rejection procedure led to the average admission of 45.85 (*SD* = 4.05) Ingroup Initial trials, 46.49 (3.36) Non-prejudiced Outgroup Initial trials, 46.68 (3.35) Prejudiced Outgroup Initial trials, 48.00 (2.65) Ingroup Final trials, 48.25 (2.50) Non-prejudiced Outgroup Final trials, and 48.03 (2.47) Prejudiced Outgroup Final trials. The minimum number of trials accepted for averaging was 30 trials per participant and condition. We did not consider behavioral data for discarding trials, thus, correctly, incorrectly, and non-responded trials were analyzed. None of the selected participants failed in the glasses task in more than 5% of the trials. Anomalous recordings in individual channels were interpolated from neighbor recordings to ensure the integrity of the 59 channel array, necessary for the spatial analyses described below. However, if more than six EEG channels (10%) presented anomalies, we discarded data from that participant. Data from ten participants were discarded for this reason. Additionally, data from five participants were discarded due to technical issues that impeded the correct recording of data, and those from other 12 participants were discarded due to their answers in the questionnaires of the Second Session (see details in Supplemental Materials).

Data analyses

Prejudice measures

In order to compare participants' attitude toward the Prejudiced Outgroup versus the Non-prejudiced Outgroup, we carried out paired-samples *t*-tests on all attitude and contact questionnaires: IAT, Affective Thermometer, Internal and External Motivation to Respond without Prejudice, the Ad-hoc Scale and the Close Contact scale. Effect sizes for these paired-samples *t*-tests were computed using Cohens's *d*.

Control analyses on attention level

To test whether all conditions were equally attended, we carried out a 3 × 2 (Group [Ingroup, Non-prejudiced Outgroup, Prejudiced Outgroup] × Moment [Initial, Final]) repeated measures analysis of variance (ANOVA) on error rates in the glasses task. Error rates were computed as the number of incorrect trials divided by the number of valid trials (i.e., trials with a response within the range between 200 and 2000 ms) in that condition.

Detection, spatiotemporal characterization, and quantification of ERP components

Detection and quantification of N170 were carried out through a covariance-matrix-based temporal PCA (tPCA), a strategy that has been repeatedly recommended for these purposes (e.g., Chapman & McCrary, 1995; Dien, 2010). In brief, tPCA computes the covariance between all ERP time points, which tends to be high between those involved in the same component and low between those belonging to different components. Once quantified in temporal terms, N170 topography at the scalp level was decomposed into its main spatial regions via a spatial PCA (sPCA) performed on temporal factor (TF) scores. sPCA provides a reliable division of the scalp into different regions or spatial factors (SFs). Basically, each SF is formed by the scalp points where recordings tend to covary. TF and SF scores are the parameters in which TFs and SFs can be quantified and are linearly related to amplitudes. The decision on the number of factors to select both in tPCA and sPCA was based on the scree test (Cliff, 1987). Extracted factors were submitted to promax rotation in both cases (Dien, 2010). Although we controlled facial attractiveness, emotional expression and luminance (see Supplemental Materials), other low-level and physical configuration characteristics may modulate N170 amplitudes (Rossion & Caharel, 2011). To test whether these characteristics differed across conditions, we also analyzed P1, an ERP component that is strongly affected by low-level characteristics of visual stimuli (Rossion & Caharel, 2011). P1 was detected, quantified and analyzed following the same procedure as for N170.

ERP analyses

Experimental effects on N170 amplitudes were tested by introducing Group (Ingroup, Non-prejudiced Outgroup, Prejudiced Outgroup) and Moment (Initial, Final) as within-participant factors in two repeated-measures ANOVAs. The same analysis was carried out for the P1 component. Additionally, and as suggested during the review process, we analyzed N170 latencies, although no hypotheses were formulated at this respect (as detailed in the Supplemental Materials, previous data are inconsistent). We computed effect sizes in these ANOVAs using the partial eta-square (η_p^2) method and used the Bonferroni correction for post-hoc comparisons to determine the significance of pairwise contrasts. The Greenhouse-Geisser (G-G) correction of F ratios was applied when sphericity, which was tested though the Mauchly's test, was violated.

Results

Prejudice measures

We computed a paired-samples *t*-test on all attitude questionnaires comparing the Non-prejudiced Outgroup versus the Prejudiced Outgroup. Participants showed more negative bias in the IAT toward the Prejudiced Outgroup (M = −0.43, SD = 0.36) compared to the Non-prejudiced Outgroup (M = −0.08, SD = 0.30), according to the Student's *t* test ($t(70) = -6.58$, p < 0.001, d = 0.78). External motivation to respond without prejudice was also greater for the Prejudiced Outgroup (M = 16.49, SD = 7.23) compared to the Non-prejudiced Outgroup (M = 13.62, SD = 6.83), as indicated by the statistical contrast ($t(70) = -5.33$, $p < 0.001$, d = 0.63). Regarding the Affective Thermometer, participants reported a "warmer" relationship with the Non-prejudiced Outgroup (M = 7.44, SD = 1.45) than with the Prejudiced Outgroup (M = 6.79, SD = 2.18), according to statistical tests ($t(70) = 2.86$, $p = 0.006$, d = 0.32).

On the other side, Internal motivation to respond without prejudice did not show a significant difference between the Prejudiced Outgroup (M = 29.92, SD = 4.57) and the Non-prejudiced Outgroup (M = 30.76, SD = 4.28; $t(70) = 1.93$, $p = 0.057$, d = 0.23). Similarly, the ad-hoc scale neither showed a significant difference between the Prejudiced Outgroup (M = 9.37, SD = 2.99) and the Non-prejudiced Outgroup (M = 9.00, SD = 2.95; $t(70) = -1.22$, $p = 0.226$, d = 0.14). Finally, participants reported having more contact with the Prejudiced Outgroup (M = 20.28, SD = 5.94) compared to the Non-prejudiced Outgroup (M = 14.58, SD = 6.15; $t(70) = -5.95$, $p < 0.001$, d = 0.71). Table 1 shows descriptive data for each test and each comparison.

Control analyses on attention level

We carried out a 3 × 2 (Group [Ingroup, Non-prejudiced Outgroup and Prejudiced Outgroup] × Moment [Initial, Final]) repeated measures ANOVA for error rates in the glasses task that served to control that all conditions were equally attended. Error rates were computed as the number of incorrect trials divided by the number of valid trials (i.e., trials with a response within the range between 200 and 2000 ms) in that condition, so this parameter ranges from 0 to 1. This ANOVA showed

Table 1. Mean and SD (in parenthesis) for prejudice measures for Non-prejudiced Outgroup (Non-P Outgroup) and Prejudiced Outgroup (P Outgroup).

	Non-P Outgroup	P Outgroup	t (70)	p-value
IAT	−0.08 (0.30)	−0.43 (0.36)	6.58	<.001
Affective Thermometer	7.44 (1.45)	6.79 (2.18)	2.86	.006
Ad-hoc prejudice	9.00 (2.95)	9.37 (2.99)	1.22	.226
External Motivation	13.62 (6.83)	16.49 (7.23)	5.33	<.001
Internal Motivation	30.76 (4.28)	29.92 (4.57)	1.93	.057
Contact	14.58 (6.15)	20.28 (5.94)	5.95	<.001

Table 2. Error rate for each condition in the habituation task (number of errors divided by number of valid trials). Mean and SD (in parenthesis) for each group at Initial and Final trials.

	Ingroup	Non-prejudiced Outgroup	Prejudiced Outgroup
Initial	.047 (0.033)	.045 (0.036)	.045 (0.039)
Final	.059 (0.053)	.055 (0.044)	.060 (0.049)

main effects for Moment, error rate being higher for Final trials compared to Initial trials ($F(1,70) = 8.32$, $p = 0.005$, $\eta^2_p = 0.106$). In any case, average error rates were 0.06 or less in all conditions. No significant effect was found for Group ($F(1,70) = 0.30$, $p = 0.739$). Again, no significant effect was found for the Moment × Group interaction ($F(1,70) = 0.163$, $p = 0.850$). Thus, all faces were equally attended regardless of their ingroup or outgroup status. Table 2 shows descriptive data of error rates for each group.

Electrophysiological measures

N170 latencies

As suggested during the review process, N170 latencies were analyzed to complement N170 amplitudes, on which the study was originally focused. Main effects of Group ($F(1,70) = 22.46$, $p < 0.001$, $\eta^2_p = 0.243$) and Moment ($F(2,140) = 10.58$, $p < 0.001$, $\eta^2_p = 0.131$) yielded significance, whereas their interaction did not ($F(2,140) = 0.823$, G-G corrected $p = 0.909$). Post-hoc comparisons showed no significant difference between the Ingroup and the Prejudiced Outgroup ($p = 0.252$), but longer latencies for the Non-prejudiced Outgroup compared to both the Ingroup ($p < 0.001$) and the Prejudiced Outgroup ($p = 0.019$). Additional details on N170 analyses and results, which are unrelated to prejudice and may be interpreted in terms of socio-affective saliency, are described and discussed in the Supplemental Materials.

Detection, spatiotemporal characterization, and quantification of N170 amplitudes. Grand averages for channel P5 (left N170) and P6 (right N170), where N170 is prominent, are presented in Figure 2e, respectively. The first analytical step consisted of detecting and quantifying left and right N170 through tPCA (see the section on Data analyses). Six TFs were extracted by tPCA and submitted to promax rotation (Figure 2a). Factor peak latency (around 186 ms after stimulus presentation) and topography characteristics revealed TF6 as the critical component (Figure 2b). Next, sPCA decomposed TF6 into four SFs or scalp regions (see Data Analyses). Among these regions, the relevant ones would be those showing occipitoparietal lateral topographies: SF4 and SF3, as can be seen in Figure 2d,f, respectively. The SF score (equivalent to amplitude, as previously explained) of SF3 and SF4 (left and right N170, respectively, from now on) was extracted per participant and condition and submitted to the statistical contrasts described below. In the case of P1, TF4 was the critical component. Factor peak latency for P1 was around 150 ms after stimulus presentation. Next, sPCA decomposed TF4 in five SFs or scalp regions, being also extracted per participant and condition; of these regions SF2 showed the characteristic occipital topography of P1, which was submitted to ANOVA analysis.

Experimental effects on N170 amplitudes. To test the experimental effects on **N170**, we carried out a 3 × 2 (Group [Ingroup, Non-prejudiced Outgroup, Prejudiced Outgroup] × Moment [Initial, Final]) repeated measures ANOVA on left and right N170 amplitudes, as indicated in the Methods section. Table 3 shows details on both ANOVAs. Figure 3 shows means and standard error of means (SEMs) of SF scores for right and left N170. A preliminary control analysis was carried out to test whether the different combinations of two faces per category presented to each participant (see the Procedure section) yielded significant differences in N170 amplitudes. To that aim, we included the factor Combination (8 levels) in this preliminary ANOVA along with Group and Moment. The effect of combination was not significant ($F(1,33) = 0.318$, $p = 0.382$), and neither its interaction with Group ($F(14, 126) = 1.612$, G-G corrected $p = 0.086$) nor with Moment ($F(7,63) = 0.565$, $p = 0.782$). Therefore, factor Combination was not included in subsequent analyses.

Right N170 ANOVA showed a main effect both for Moment, indicating a greater N170 for Initial trials (*F*

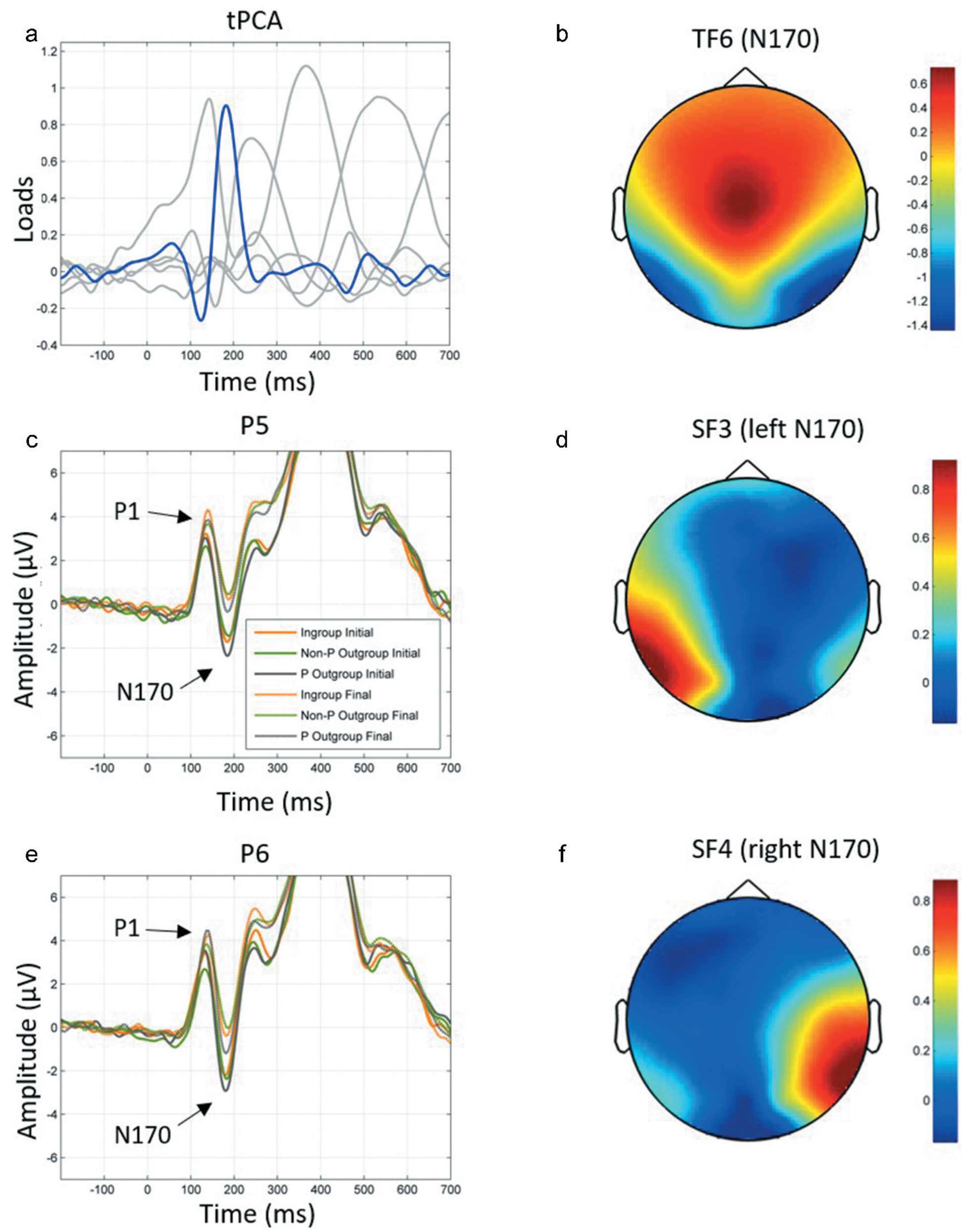

Figure 2. a: Loads for temporal factor 6 (blue) at each time point. b: loads for temporal factor 6 on each channel. c: Right N170 at P6 channel. d: Loads for spatial factor 3 on each channel. e: Left N170 at P5 channel. f: Loads for spatial factor 4 on each channel.

(1,70) = 24.46, $p < 0.001$, $\eta_p^2 = 0.259$) and for Group (F(2,140) = 8.478, $p < 0.001$, $\eta_p^2 = 0.108$). Post-hoc comparisons for Group showed no significant difference between the Ingroup and the Non-prejudiced Outgroup (p = 1.00), but greater (i.e., more negative) N170 amplitude for the Prejudiced Outgroup than for the Ingroup (p = 0.002) and for the Non-prejudiced Outgroup (p = 0.001). The Moment × Group interaction did not yield significant effects (F(2,150) = 0.566, G-G corrected p = 0.552).

Left N170 ANOVA also showed a significant main effect for Moment, being greater for Initial trials (F(1,70) = 59.669, $p < 0.001$, $\eta_p^2 = 0.460$). The main effect of Group was also significant (F(2,140) = 4.485, $p < 0.013$, $\eta_p^2 = 0.060$). Post-hoc comparisons for Group showed no significant difference between the Ingroup and the Non-prejudiced Outgroup (p = 1.00), but greater amplitude for the Prejudiced Outgroup than for both the Ingroup (p = 0.051) and the Non-prejudiced Outgroup (p = 0.037). No significant effect for the Moment × Group interaction was found (F(2,140) = 0.303, p = 0.739).

An equivalent 3 × 2 ANOVA was carried out for **P1**, as explained. This ANOVA yielded a significant main effect of Group (F(2,140) = 4.296, p = 0.015, $\eta_p^2 = 0.058$). Post-

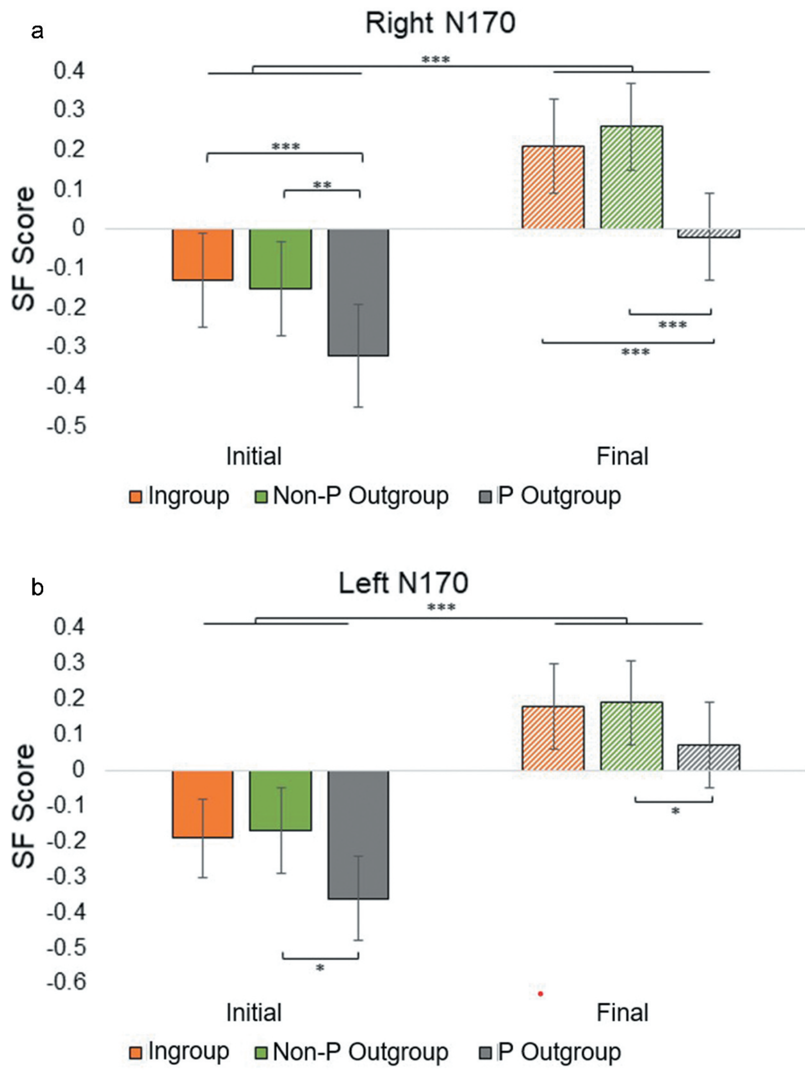

Figure 3. a: Right N170 spatial factor 4 score (linearly related to amplitude). Bars show mean and SEM for each group at the beginning (Initial 50 trials) and at the end (Final 50 trials). b: Left N170 spatial factor 3 score (linearly related to amplitude). Bars show mean and SEM for the Ingroup, the Prejudiced Outgroup (P Outgroup), and the Non-Prejudiced Outgroup (Non-P Outgroup) at the beginning (Initial 50 trials) and at the end (Final 50 trials). $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .005$.

Table 3. Results (F, Probability [p], and Effect Size[η_p^2]) yielded by the Repeated Measures Two-way ANOVA involving Group and Moment factors.

		Right N170	Left N170	P1
Group	$F(2,140)$	8.478	4.485	4.296
	p	.001	.001	.015
	η_p^2	0.108	0.060	0.058
Moment	$F(1,70)$	24.462	59.669	4.738
	p	<.001	.001	.033
	η_p^2	0.259	0.460	0.063
Interaction	$F(2,140)$	0.556	0.303	0.649
	p	.552	.739	.524
	η_p^2	0.008	0.004	0.009

hoc comparisons showed that P1 was greater for the Prejudiced Outgroup compared to the Non-prejudiced Outgroup (p = 0.005). No other pairwise comparisons were significant. The Moment main effect was also significant ($F(1,70) = 4.738$, $p = 0.033$, $\eta^2_p = 0.063$). P1 amplitude was greater for the Final trials than for the Initial trials. The Group × Moment interaction effect was not significant ($F(2,140) = 0.649$, $p = 0.524$). Since P1 effects might influence N170, we carried out an additional ANCOVA to explore whether the effects observed in N170 were explained, at least partially, for the neural processes reflected in P1. ANCOVA analysis was carried out on N170 amplitudes introducing the same variables as in the ANOVA, plus P1 amplitudes as a covariate. Regarding *right N170*, results showed that, after removing the effects of P1 from the model, Group main effect remained significant in N170 ($F(2,327) = 8.733$, $p <$ 0.001). Post-hoc comparisons also revealed the same effects as in the ANOVA described above (i.e., more negative N170 for the Prejudiced Outgroup compared to both the Ingroup and the Non-prejudiced Outgroup, all $p < 0.005$). Main effect of Moment also remained greater for the Initial trials than for the Final trials ($F(1,356) = 11.505$, $p = 0.001$). Again, no Group × Moment interaction was observed ($F(2,324) = 0.212$, $p = 0.809$). For *left N170*, main effect of Group also remained significant ($F(2,330) = 4.196$, $p = 0.016$). However, whereas post-hoc analyses confirmed that left N170 amplitude was greater for the Prejudiced Outgroup compared to the Non-prejudiced Outgroup ($p = 0.021$), differences between the former and the Ingroup lost significance this time ($p = 1.000$). In the case of the left N170 component, Moment main effect remained also significant after controlling for P1 ($F(1,357) = 29.493$, $p < 0.001$). No Group × Moment interaction was found ($F(2,326) = 0.452$, $p = 0.637$).

Relationship between N170 amplitude and prejudice measures. To explore the relationship between prejudice measures and habituation, indexed through N170 amplitude decrease, it was necessary to reduce N170 amplitude to two group levels (i.e., the same levels of the prejudice measures) without losing relevant information. We only carried out this analysis for right N170 given that it was the only component that remained unchanged after including P1 as a covariate. To that aim, we calculated a habituation index for each Outgroup. That is, we computed the habituation to each Outgroup by comparing the decrease of the right N170 amplitude for the Ingroup with the decrease of the right N170 to each Outgroup using the following formula:

$$(OutgN170Initial - OutgN170Final) - (IngN170itial - IngN170Final)$$

A positive score in this habituation index means greater habituation for the Ingroup than for the Outgroup and vice versa. Given that in the Second Session we obtained prejudice indices for each Outgroup, we computed a stepwise Multiple Regression model to determine if this N170 habituation index may be explained by one or more of the prejudice measures that had shown significant differences between groups (i.e., IAT, Affective Thermometer, and External motivation to respond without prejudice). We found that IAT scores were able to explain right N170 differences in habituation between the Non-prejudiced and the Prejudiced Outgroup, compared to the Ingroup ($F(1,140) = 5.487$, $p = 0.021$, $\beta = -0.194$, $R^2 = 0.031$). However, the Affective Thermometer and External Motivation measures seemed to be redundant after including IAT in the regression model (p of all $\beta > 0.05$). This inverse relation means that the smaller the habituation to the Outgroup (as compared to the Ingroup), the more negative the IAT score (i.e., more implicit prejudice).

Discussion

In the present study we aimed to shed light on the question whether differential habituation to an outgroup compared to an ingroup is due to its association with negative concepts (e.g., prejudice) or solely due to the lack of perceptive experience with this outgroup. To this end, participants habituated to faces pertaining to their Ingroup, an outgroup with greater probability to be related to negative concepts (Prejudiced Outgroup), and an outgroup with lower probability to be related to negative concepts (Non-prejudiced Outgroup), while N170 amplitude was recorded. Additionally, prejudice measures were collected.

Three of the results obtained for the prejudice scales corroborated that prejudice was greater for the Prejudiced Outgroup compared to the Non-prejudiced Outgroup. First, participants showed a more negative bias in the IAT toward the Prejudiced Outgroup compared to the Non-prejudiced Outgroup. Second, the Affective Thermometer scores showed that participants reported a "warmer" relationship with the Non-prejudiced Outgroup compared to the Prejudiced Outgroup. And third, External motivation to respond without prejudice was greater for the Prejudiced Outgroup compared to the Non-prejudiced Outgroup, while Internal motivation to respond without prejudice did not show significant differences. According to Devine et al. (2002) only people with low external motivation to respond without prejudice are truly unprejudiced, thus, we interpret this result as compatible with the view that our sample as a whole holds stronger prejudices against the Prejudiced Outgroup compared to the Non-prejudiced Outgroup. The lack of significant differences in the three items of the Ad-hoc scale might be due to participants trying not to explicitly show their true beliefs. Importantly, the Close Contact scale showed that participants had more contact with members from the Prejudiced Outgroup. Thus, perceptual experience for faces from that group is more frequent in the experimental sample than for faces from the Non-prejudiced Outgroup.

Regarding right and left N170 component amplitude, we did not find a significant interaction effect between Moment and Group, so our results do not support a differential habituation for any Outgroup faces compared to Ingroup faces. Instead, main effects of both the Moment within the experimental run in which faces appeared, and the Group to which they belonged, resulted significant. Thus, a significant difference in the amplitude of N170, which was greater for Initial compared to Final trials for all groups, was observed. In other words, participants showed an undifferentiated pattern of habituation to all faces regardless their ethnic characteristics. We also found a significant difference in the amplitude of N170 as a function of the type of group faces belonged to, being greater for faces of the Prejudiced Outgroup than for faces of both the Ingroup and the Non-prejudiced Outgroup (as indicated by post-hoc comparisons). Control analysis on the level of attention showed that error rates were not different between groups, so this factor does not seem to explain the experimental effects regarding group. Error rates for Final trials were greater than for Initial trials so, even being very low (< .06), as explained, they may be also an index of habituation. Alternatively, this finding may be a fatigue effect since, as indicated, the task involved 600 trials. However, although we did not find N170 evidence for differential habituation between ethnic groups taking the participant sample as a whole, the regression analysis revealed that individual habituation to the Outgroup faces was inversely related to implicit prejudice scores. In other words, those participants with a higher degree of implicit prejudice toward certain Outgroup habituated to a lesser extent (as reflected in N170 amplitude) to faces from that Outgroup. Thus, we cannot discard that the prejudice that a person holds toward an Outgroup may explain habituation-related N170 amplitude changes.

An interesting result regarding N170 amplitude is worth being further discussed. Right N170 showed greater amplitude specifically for the Prejudiced Outgroup compared to the Ingroup and the Non-prejudiced Outgroup. An interpretation of this modulation of N170 by the ethnical background of faces is not straightforward, as indicated in the Introduction. Some authors argue that the lack of perceptive experience -unfamiliarity- with faces from an outgroup disrupts the holistic processing that is characteristic of faces (Caharel et al., 2011; Ran et al., 2014; Stahl et al., 2008). Importantly, the present experiment shows that the N170 bias toward de Prejudiced Outgroup remained after habituation through 100 repetitions of each facial condition. In other terms, the Moment x Group interaction was not significant, pointing to a steady N170 bias. In our study, faces belonging to two Outgroups were presented to participants, both unfamiliar to them so, if perceptive experience were the main explaining factor, both outgroup conditions should have enhanced N170 amplitude (which would be even greater for the Non-prejudiced Outgroup given that participants reported more contact with the Prejudiced Outgroup). Additionally, if lack of perceptive experience drove this effect, it should have disappeared, or at least significantly diminished, during the Final trials (i.e., a Moment x Group interaction should have been observed). As indicated, this was not the case. These results point to a crucial influence of prejudice on the observed N170 effects. However, the influence of perceptual expertise may not be completely ruled out, and neither the possibility that familiarity could require different rates of habituation for each social group to manifest its influence in this ERP component.

An alternative and most probable explanation regarding this N170 bias, as Herrmann et al. (2007) have argued, is that the emotional valence of an outgroup (e.g., prejudice) may drive the vast majority of the increase in N170. Indeed, N170 amplitude has been shown to be enhanced for negative valenced facial expressions (see a meta-analysis in Hinojosa et al., 2015). That is, although we controlled for facial expression, N170 might be driven by the negative valence that the Prejudiced Outgroup evoked in the experimental sample. This valence effect would interact with cognitive processes such as attention. Indeed, given that N170 amplitude is enhanced when a face is attended versus when it is not (Li et al., 2016; Mohamed et al., 2009; Nasr, 2010), the N170 bias observed here could reflect increased attentional resources devoted to the Prejudiced Outgroup due to its negative valence for our sample of participants. In relation to this, most of the previous studies that explored the modulation of N170 amplitude by the ethnic background of faces did not measure prejudice toward them, and this could explain divergent results. The possibility that prejudice was lower, or inexistent, in those studies failing to show enhanced N170 amplitudes toward outgroup faces should not be discarded. A question that arises is whether this component, widely accepted to reflect the processing of facial structural configuration (c.f., Eimer, 2011), may be affected by high-level parameters such as prejudice. At his respect, it is important to note that several high-level mechanisms as biographical information (Galli et al., 2006), context generated by other faces (e.g., Lin et al., 2015) or emotional expressions -and their social meaning- (e.g., Hinojosa et al., 2015) also affect N170. Prejudice would potentially involve these high-order influences, since certain biographical, contextual and/or emotional inferences may be automatically triggered by out- and ingroup faces (e.g., respectively, Christ et al., 2014; Cottrell & Neuberg, 2005; Hornsey et al., 2002).

In conclusion, habituation in the sample as a whole, as measured through ANOVAs on N170 amplitudes, seemed not to be modulated by the ethnical background of faces, since it did not differ between Ingroup, Prejudiced Outgroup, and Non-prejudiced Outgroup faces. However, the regression analysis showed that individual implicit prejudice could indeed explain differential ethnical habituation. This mixed evidence points to a possible modulation of habituation by prejudice that requires further research preferentially focused on the individual level (individual prejudices) rather than at the global (sample) level. Importantly, we found an enhancement of N170 amplitude in response to faces of the outgroup toward which there was a prevailing prejudice -according to the scales administered to participants-, a bias which remained after stimulus repetition. This effect cannot be explained by the lack of perceptive experience, as discussed in detail above. This study stresses the usefulness and relevance of recording electrophysiological indices – particularly N170- as well as subjective measures of prejudice in future studies within this field of research. Controlling for factors such as the individual expertise in facial perception, the so-called "other-race effect" (i.e., worse recognition of outgroup individuals -an effect which is not incompatible with prejudice-) or the low-level characteristics of faces, always relevant in ERP research, seems also necessary. Manipulating facial expressions and their interaction with ethnic background would be also of primary interest, given that, as explained, prejudice may be ultimately linked to emotional valence.

Disclosure statement

Authors declare no conflict of interest.

Funding

This work was supported by the Ministerio de Ciencia e Innovación, Spain [PGC2018-093570-B-I00]; Ministerio de Educación, Cultura y Deporte, Spain [FPU13/06512]; Comunidad de Madrid, Spain [grants HUM19–HUM5705, SI1-PJI-2019-00011, and, along with Universidad Autónoma de Madrid, Spain, 2017-T2/SOC-5569].

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Data availability

EEG, behavioral and second session data is available at https://osf.io/54e2u/.

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