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1 Somatosensory evoked potentials reveal reduced embodiment of  
2 emotions in autism

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18 **Conflict of interest**

19 The authors declare no conflict of interest.

20

21 **Abstract**

22 Consistent with current models of embodied emotions, this study investigates whether the  
23 somatosensory system shows reduced sensitivity to facial emotional expressions in autistic  
24 compared to neurotypical individuals, and if these differences are independent from between-  
25 group differences in visual processing of facial stimuli. To investigate the dynamics of  
26 somatosensory activity over and above visual carryover effects, we recorded EEG activity from  
27 two groups of Autism Spectrum Disorder (ASD) or Typically Developing (TD) humans (male  
28 and female), while they were performing a facial emotion discrimination task and a control  
29 gender task. To probe the state of the somatosensory system during face processing, in 50% of  
30 trials we evoked somatosensory activity by delivering task-irrelevant tactile taps on  
31 participants' index finger, 105 ms after visual stimulus onset. Importantly, we isolated  
32 somatosensory from concurrent visual activity by subtracting visual responses from activity  
33 evoked by somatosensory and visual stimuli. Results revealed significant task-dependent group  
34 differences in mid-latency components of Somatosensory Evoked Potentials (SEPs). ASD  
35 participants showed a selective reduction of SEP amplitudes (P100) compared to TD during  
36 emotion task, and TD, but not ASD, showed increased somatosensory responses during  
37 emotion compared to gender discrimination. Interestingly, autistic traits, but not alexithymia,  
38 significantly predicted SEP amplitudes evoked during emotion, but not gender, task.  
39 Importantly, we did not observe the same pattern of group differences in visual responses. Our  
40 study provides direct evidence of reduced recruitment of the somatosensory system during  
41 emotion discrimination in ASD and suggests that this effect is not a by-product of differences  
42 in visual processing.

43

44

45 **Significance Statement**

46 The somatosensory system is involved in embodiment of visually presented facial expressions  
47 of emotion. Despite autism being characterised by difficulties in emotion-related processing,  
48 no studies have addressed whether this extends to embodied representations of others'  
49 emotions. By dissociating somatosensory activity from visual evoked potentials, we provide  
50 the first evidence of reduced recruitment of the somatosensory system during emotion  
51 discrimination in autistic participants, independently from differences in visual processing  
52 between typically developing and ASD participants. Our study employs a novel methodology  
53 to reveal the neural dynamics underlying difficulties in emotion recognition in ASD and  
54 provides direct evidence that embodied simulation of others' emotional expressions operates  
55 differently in autistic individuals.

56

## 57 **Introduction**

58 Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterised by  
59 differences in processing social and sensory information and by repetitive patterns of interests  
60 and behaviours (American Psychiatric Association, 2013). Within social perception, autistic  
61 individuals often demonstrate difficulties in facial emotion recognition (Harms et al., 2010;  
62 Gaigg, 2012; Uljarevic & Hamilton, 2013; Loth et al., 2018, but see Bird & Cook, 2013), which  
63 has been associated with reduced sensitivity to emotional expressions in visual cortices  
64 (Dawson et al., 2005; Deeley et al., 2007; Apicella et al., 2013; Black et al., 2017; Martínez et  
65 al., 2019).

66 Studies in Typically Developing (TD) individuals suggest that beyond the visual analysis of  
67 faces, perceiving emotional expressions triggers embodied resonance (Sinigaglia & Gallese,  
68 2018) in sensorimotor regions, which implies re-enacting the visceral, somatic, proprioceptive  
69 and motor patterns associated with the observed expressions (Goldman & Sripada, 2005;  
70 Hennenlotter et al., 2005; Heberlein & Adolphs, 2007; Niedenthal, 2007; Keysers & Gazzola,  
71 2009, 2010). Research using TMS (Pourtois et al., 2004; Pitcher et al., 2008) and lesion  
72 methods (Adolphs et al., 1996, 2000; Atkinson and Adolphs, 2011) have also demonstrated a  
73 causal role of the right somatosensory cortex in facial emotion recognition. Importantly, EEG  
74 studies directly measuring Somatosensory Cortex (SCx) activity disentangling Visual and  
75 Somatosensory Evoked Potentials (V/SEP), have shown SCx engagement in facial emotion  
76 recognition over and above any visual carry-over activity (Sel et al., 2014; Sel et al., 2020),  
77 providing neural evidence of embodiment of emotional expressions beyond the visual analysis  
78 of emotions.

79 These embodied simulative mechanisms operate differently in ASD. FMRI studies comparing  
80 autistic and TD individuals have shown reduced embodied resonance of vicarious affective

81 touch in the SCx (Masson et al., 2019), and decreased activity in the Premotor Cortex, the  
82 Amygdala and the Inferior Frontal Gyrus during perception of dynamic bodily emotional  
83 expressions (Grèzes et al., 2008). In another TMS study, ASD participants showed significantly  
84 reduced modulations of Motor Evoked Potentials (MEP) during observation of painful stimuli  
85 delivered to someone's hand (Minio-Paluello et al., 2009). Together with studies suggesting  
86 reduced mirror activity in autistic individuals during observation and imitation of actions  
87 (Oberman et al., 2005, 2008) and emotional expressions (Dapretto et al., 2006; Greimel et al.  
88 2010), the evidence suggests that some of the differences in social-emotional cognition  
89 characterising ASD are related to reduced simulation of observed actions and feelings.  
90 However, the specific processes involved remain the topic of debate, partly because of  
91 methodological challenges in dissociating the multiple neural underpinnings of the perception  
92 and understanding of other's emotional expressions, such as visual and sensorimotor cortices  
93 (see Galvez-Pol et al., 2020).

94 This study aims to investigate whether emotion processing in ASD is associated with reduced  
95 somatosensory activations, over and above differences in visual responses. To this aim, we  
96 recorded simultaneous visual and somatosensory evoked potentials by means of  
97 electroencephalography (EEG) in two groups of autistic individuals and matched TD controls  
98 during a visual emotion discrimination task and a control task, requiring participants to judge  
99 either the emotion or the gender of the same facial stimuli. Importantly, we directly measured  
100 somatosensory activity by evoking task-irrelevant SEPs (Auksztulewicz et al., 2012) in 50%  
101 of trials during the visual tasks. Based on previous research, we used a subtractive method to  
102 isolate somatosensory responses from visual carry-over effects (Dell'acqua et al., 2003; Sel et  
103 al., 2014; Arslanova et al., 2019; Sel et al., 2020; Galvez-Pol et al., 2018a, 2018b, 2020), thus  
104 directly probing the dynamics of somatosensory activity during discrimination of emotional  
105 expressions. Moreover, we explored how differences in embodiment of emotional expressions

106 relate to autistic traits, and measures of alexithymia and interoceptive awareness, which have  
107 been argued to contribute to emotion processing differences in autism (Bird & Cook, 2013,  
108 Garfinkel et al., 2016). We predicted to observe decreased modulations of SEP amplitudes (free  
109 from visual activity) in ASD compared to TD, reflecting reduced embodiment of emotional  
110 expressions in autistic individuals.

111

## 112 **Materials and Methods**

113 *Participants.* Twenty-two adult participants with a diagnosis of Autism Spectrum Disorder  
114 (ASD) and twenty-two Typically Developing (TD) adults matched for IQ, age and gender  
115 took part in the experiment. Datasets from two participants (1 ASD, 1 TD) were not included  
116 in the final analyses because stimulus markers were accidentally not recorded during data  
117 collection. We excluded two additional ASD participants because of excessive artefacts in the  
118 EEG data (drift due to sweat and artefacts caused by muscular tension) and two TD  
119 participants because they scored above cut off on the Social Responsiveness Scale (SRS-2)  
120 and Autism Quotient (AQ) respectively. We ensured that there was no significant difference  
121 in artefact rejection between the two groups. The final sample was thus composed of 19 ASD  
122 (17 right handed, 1 female, mean age  $40.47 \pm 8.87$ ) and 19 TD participants (19 right handed,  
123 1 female, mean age  $40.84 \pm 12.25$ ). The sample size was extracted from a study by Sel and  
124 colleagues (Sel et al., 2014), adopting a similar paradigm in typically developing participants  
125 ( $n = 16$ ). We ensured to achieve high statistical power by administering a large number of  
126 trials per experimental condition, in line with recent literature (Baker et al., 2020, Boudewyn  
127 et al., 2018) showing that, in ERP studies, statistical power increases as a function of the  
128 interaction between sample size, effect size, and number of trials. Moreover, a post-hoc  
129 sensitivity analysis was carried out in GPower (Perugini et al., 2018) to determine the

130 smallest effect size which could be reliably detected by our  
131 Group\*Task\*Hemisphere\*Region\*Site\*Emotion (2\*2\*2\*3\*3\*3) repeated-measures  
132 ANOVA, given our sample size (n = 38), an alpha level of .05, and power of .80. Results  
133 highlighted that the smallest detectable effect size was .07, and the critical F was 1.24,  
134 confirming the validity of our results.

135 All participants in the ASD group had a formal diagnosis of autism spectrum disorder from  
136 qualified professional clinicians based on the DSM criteria. To control for IQ, we tested all our  
137 participants with a short version of the Weschler Adult Intelligence Scale (WAIS), and  
138 obtained a Verbal IQ (VIQ) and Performance IQ (PIQ) for each participant. Moreover,  
139 participants completed the adult self-report form of the Social Responsiveness Scale (SRS-2;  
140 Constantino and Gruber, 2012)), the Autism-Spectrum Quotient (AQ; Baron-Cohen et al.,  
141 2001), the Toronto Alexithymia Scale (TAS-20; Bagby et al., 1994)) and the Multidimensional  
142 Assessment for Interoceptive Awareness (MAIA-2; Mehling et al., 2018). For a summary of  
143 test and questionnaires scores, see Table 1.

144 *Stimuli.* We used a set of pictures depicting neutral, fearful and happy emotions used in a  
145 previous study (Sel et al., 2014), originally selected from the Karolinska Directed Emotional  
146 Faces set (Lundqvist et al., 1998). The grayscale faces were enclosed in a rectangular frame  
147 (140 x 157 inches), excluding most of the hair and non-facial contours.

148 *Task.* Participants sat in an electrically shielded chamber (Faraday's cage) in front of a monitor  
149 at a distance of 80 cm. Visual stimuli were presented centrally on a black background using E-  
150 Prime software (Psychology Software Tools). Trials started with a fixation cross (500 ms),  
151 followed by the presentation of a face image (neutral, fearful or happy, either male or female)  
152 for 600 ms.

153 The experiment consisted of 1200 randomised trials, presented in two separate blocks of 600  
154 trials, which included 200 neutral, 200 fearful and 200 happy faces (half male and half female),  
155 presented in random order. In the emotion task (block 1), participants were instructed to attend  
156 to the emotional expression of the faces, while in the gender task (block 2) they needed to  
157 attend to the gender of the faces. The order of presentation of the two blocks was  
158 counterbalanced across participants. To ensure participants were attending to the stimuli, in  
159 10% of emotion block trials, participants were asked whether the face stimulus was fearful (Is  
160 s/he fearful?) or happy (Is s/he happy?), or whether it depicted a female (Is s/he female?) or  
161 male (Is s/he male?) during the gender block trials. When a question was presented, participants  
162 had to respond vocally (yes/no) as soon as possible. Responses were recorded with a digital  
163 recorder and manually inserted by the experimenter, who was able to hear the participant from  
164 outside the Faraday's cage through an intercom. Before starting each block, participants  
165 completed a practice session with 12 trials (4 neutral, 4 happy, 4 fearful, half male/female).

166 To evoke SEPs during the task, in 50% of trials (Visual-Tactile Condition; VTC), participants  
167 received task-irrelevant tactile taps on their left index finger 105 ms after face images onset  
168 (Sel et al., 2014). In the Visual-Only Condition (VOC, 50% of trials), the same visual facial  
169 stimuli were presented without any concurrent tactile stimulation (see Figure 1A for an  
170 illustration of a trial). VTC and VOC were equally distributed in each block across the stimulus  
171 types (emotion, gender).

172 Tactile taps were delivered using two 12 V solenoids driving a metal rod with a blunt conical  
173 tip that contacted participants' skin when a current passed through the solenoids. Participants  
174 were instructed to ignore the tactile stimuli. To mask sounds made by the tactile stimulators,  
175 we provided white noise through one loudspeaker placed 90 cm away from the participants'  
176 head and 25 cm to the left side of the participants' midline (65 dB, measured from the  
177 participants' head location with respect to the speaker).

178 After completing the experimental task, every participant completed a brief rating task in which  
179 they rated the previously observed expressions from 0 (extremely happy) through 50 (neutral)  
180 to 100 (extremely fearful) using a Visual Analogue Scale (VAS). On separate trials they also  
181 rated gender from 0 (extremely female) to 100 (extremely male).

182 *EEG recording and data pre-processing.* We recorded EEG from a 64 electrodes cap (M10  
183 montage; EasyCap). All electrodes were on-line referenced to the right earlobe and off-line re-  
184 referenced to the average of all channels. Vertical and bipolar horizontal electrooculogram and  
185 heartbeats were also recorded. Continuous EEG was recorded using a BrainAmp amplifier  
186 (BrainProducts; 500 Hz sampling rate).

187 Analysis of the EEG data were performed using BrainVision Analyzer software  
188 (BrainProducts). The data was digitally low-pass-filtered at 30 Hz and high-pass-filtered at 0.1  
189 Hz. Ocular correction was performed (Gratton et al., 1983) and the EEG signal was epoched  
190 into 700 ms segments, starting 100 ms before visual (for VEP analysis) and tactile (for SEP  
191 analysis) stimulus onsets. We performed baseline correction using the first 100 ms before  
192 stimulus onsets. Artefact rejection was computed eliminating epochs with amplitudes  
193 exceeding 100  $\mu$ V. Single-subject grand-averaged ERPs for each condition (VOC and VTC),  
194 task (Emotion, Gender) and emotion (Neutral, Fearful, Happy) were computed. For SEPs, after  
195 pre-processing, single-subject averages of VOC trials were subtracted from single-subject  
196 averages of VTC trials, in order to isolate somatosensory evoked responses from visual  
197 carryover effects (Galvez-Pol et al., 2020). This subtractive method is described in Figure 1B.

### 198 *Statistical analysis*

199 *Accuracy of catch-trials.* We extracted the mean accuracy for each participant, expressed in a  
200 value in a range between 0 (0% of correct answers) and 1 (100% correct answers). Exclusion  
201 criteria was set to accuracy below 50%. We computed a 2x2 frequentist and Bayesian mixed

202 repeated-measures ANOVA with group (TD, ASD) as a between factor and task (Emotion,  
203 Gender) as a within factor.

204 *Visual Analogue Sscale (VAS) ratings.* We computed two frequentist and Bayesian mixed  
205 repeated-measured ANOVAs for emotion and gender ratings separately. For emotion ratings,  
206 factors were group (TD, ASD) as between factor and emotion (Neutral, Fearful, Happy) as  
207 within factor. For gender ratings, factors were group (TD, ASD) as between factor and gender  
208 (Female, Male) as within factor.

209 *Amplitudes of SEP.* We computed mean amplitudes of SEP in four consecutive time windows  
210 of 30 ms length starting from 40 ms up to 160 ms after tactile stimulus onset (occurring after  
211 105 ms of visual stimulus onset). These time windows were centred on the P50 (40-70 ms),  
212 N80 (70-100 ms), P100 (100-130 ms) and N140 (130-160 ms) peaks (Eimer & Forster, 2005;  
213 Bufalari et al., 2007; Schubert et al., 2008). Analyses were restricted to 18 electrodes located  
214 over sensorimotor areas (corresponding to FC1/2, FC3/4, FC5/6, C1/2, C3/4, C5/6, Cp1/2,  
215 Cp3/4, CP5/6, of the 10/10 system) (Sel et al. 2014). We selected the time windows from the  
216 grand average of all conditions and participants (Luck, 2014). SEP mean amplitudes were  
217 analysed through mixed repeated-measures ANOVAs in SPSS and JASP. Consistent with  
218 previous analyses (Sel et al., 2014), within-group factors of the ANOVAs were: task (Emotion,  
219 Gender), emotion (Neutral, Fearful, Happy), hemisphere (Left, Right), site (Dorsal,  
220 Dorsolateral, Lateral; i.e., clusters of three electrodes grouped in parallel to the midline), region  
221 (Frontal, Central, Posterior; i.e., clusters of three electrodes grouped perpendicularly to the  
222 midline) and the between factor group (TD, ASD). Follow-up ANOVAs and two-tailed  
223 independent and paired sample t-tests were carried out to follow-up significant interactions,  
224 and post-hoc pairwise comparisons were computed on significant main effects. We applied  
225 Greenhouse-Geisser when appropriate (Keselman & Rogan, 1980) and post-hoc tests were  
226 corrected for multiple comparisons (Bonferroni). In order to evaluate the likelihood of the

227 experimental hypothesis over the null hypothesis, we ran additional Bayesian statistics in JASP  
228 (Caspar et al., 2020). Bayesian repeated-measures ANOVAs were run to test the likelihood of  
229 inclusion of specific interaction or main effect ( $BF_{incl}$ ) across matched models, as  
230 recommended in Keyzers et al., 2020. Only factors of interest were included to reduce the  
231 computational cost of the analyses. Bayesian model comparisons on high-order interactions  
232 with  $\geq 5$  factors could not be computed in JASP because they exceeded the computational  
233 capacity of the software, therefore only follow-ups (including  $\leq 4$  factors) on these interactions  
234 were computed. Bayesian independent and paired t-tests were run in JASP (Keyzers et al.,  
235 2020, van Doorn et al., 2021) to support the experimental hypothesis or to provide evidence of  
236 absence of effects (Keyzers et al., 2020) over the control condition. In cases where a one-tailed  
237 hypothesis was tested, the directionality of the hypothesized effect is indicated as a subscript  
238 to the BF (e.g.  $BF_{+0}$  for a positive effect,  $BF_{-0}$  for a negative effect) (Caspar et al., 2020). Priors  
239 were set in accordance with default parameters (Cauchy distribution with a Scale parameter of  
240  $r = \sqrt{2/2} \approx 0.707$ ) to provide an objective reference to our analysis (Keyzers et al., 2020), and  
241 robustness check was used to test sensitivity of results to changes in prior's features. For H1, a  
242 Bayes factor between 1 and 3 is considered anecdotal evidence, a Bayes factor between 3 and  
243 10 is considered moderate evidence, and a Bayes factor greater than 10 is considered strong  
244 evidence; for H0, a Bayes factor between 1 and 1/3 is considered anecdotal evidence, a Bayes  
245 factor between 1/3 and 1/10 is considered moderate evidence, and a Bayes factor smaller than  
246 1/10 is considered strong evidence (Jeffreys, 1998; Keyzers et al., 2020; van Doorn et al.,  
247 2021).

248 *Amplitudes of VEP.* We used single-subject averages of VEPs on the data corresponding to the  
249 visual-only condition and free from any contamination from SEPs. Analyses were computed  
250 on 30 ms time windows, centred on the visual components P1 (120-150 ms), N2 (170-200 ms)  
251 and P3 (240-270 ms). ERPs were computed at occipital sites (corresponding to O1/2, O9/10,

252 PO9/10 electrodes of the 10/10 system) (Conty et al., 2012). We selected the time windows  
253 from the grand average of all conditions and participants (Luck, 2014). VEP mean amplitudes  
254 were analysed through mixed repeated-measures ANOVAs in SPSS, including the factors  
255 group (TD, ASD), task (Emotion, Gender) hemisphere (Left, Right), electrode (corresponding  
256 to O1/2, O9/10, PO9/10 electrodes of the 10/10 system) and emotion (Neutral, Fearful, Happy).  
257 We applied Greenhouse-Geisser correction for non-sphericity when appropriate (Keselman &  
258 Rogan, 1980) and post-hoc tests were corrected for multiple comparisons (Bonferroni).

259 In addition, Bayesian repeated-measures ANOVAs, independent and paired t-tests were run in  
260 JASP to evaluate the likelihood of H1 over the null hypothesis or to provide evidence in favour  
261 of H0 (Keysers et al., 2020; van Doorn et al., 2021). The parameters used were consistent with  
262 SEP analysis.

### 263 *Correlations and linear regressions between personality traits and SEP and VEP amplitudes*

264 We first ran correlations between questionnaires scores (Social Responsiveness Scale (SRS-  
265 2); Autism Quotient (AQ); Toronto Alexithymia Scale (TAS-20); Multidimensional  
266 Assessment of Interoceptive Awareness (MAIA-2)) to examine associations between  
267 personality traits. Then, we computed correlations in SPSS with the aim to explore linear  
268 relationships between autism, alexithymia and interoception, and somatosensory and visual  
269 responses to emotional faces. Specifically, we tested if individual scores on questionnaires  
270 measuring autistic traits (SRS-2 and AQ), alexithymia (TAS- 20) and interoceptive awareness  
271 (MAIA-2) significantly correlated with SEP and VEP amplitudes during emotion and gender  
272 tasks. We focused on the SEP and VEP components and clusters of electrodes where significant  
273 group effects were found. We first ran correlations on the whole sample, and then on the ASD  
274 group only. Then, we ran a multiple linear regression including as predictors of SEPs the scores  
275 on the four questionnaires. In addition, Bayesian correlations and linear regressions were

276 computed in JASP to provide evidence in favour or against our experimental hypotheses. In  
277 cases where a one-tailed hypothesis was tested, the directionality of the hypothesized effect is  
278 indicated as a subscript to the BF (e.g.  $BF_{+0}$  for a positive effect,  $BF_{-0}$  for a negative effect)  
279 (Caspar et al., 2020).

## 280 ***Source Reconstruction***

281 We performed source reconstruction of SEPs with SPM 12 (Ashburner et al., 2014) using a  
282 standard MRI template with the COH – Smooth Priors method (Friston et al., 2008), a source  
283 reconstruction method assuming locally coherent and distributed sources (Bonaiuto et al.,  
284 2018) equivalent to LORETA (Pascual-Marqui et al., 1994; Pascual-Marqui, 2002). We  
285 performed source analysis on segments of 150 ms, 200 ms and 300 ms length, starting from  
286 tactile onset. The segments were grand-averaged across subjects (Fogelson et al., 2014;  
287 Ranlund et al., 2016) for each group and task. We specified two conditions for each group  
288 (Emotion Task and Gender Task) which were source reconstructed separately. After inverting  
289 the three models, we selected the model with the highest log-evidence or marginal likelihood  
290 (Friston et al., 2008) We extracted the MNI coordinates of the voxel showing the strongest  
291 level of activity for each SEP peak of interest (P50: 50 ms; N80: 90 ms; P100: 110 ms; N140:  
292 145 ms) and converted to Brodmann areas with the Atlas Bioimage Suite Web (Papademetris  
293 et al., 2006).

294

## 295 **Results**

### 296 *Behavioural Performance on Face Emotion and Gender catch trials during EEG recording.*

297 The mixed repeated-measures ANOVA showed a significant main effect of group  
298 ( $F_{(1,36)}=5.396$ ,  $\eta^2=.130$ ,  $p=.026$ ,  $BF_{incl}=2.402$ ), explained by an overall decreased accuracy  
299 for the ASD ( $M=88.6\%$ ,  $SD=1.9\%$ ) compared to the TD group ( $M=95.0\%$   $SD=1.9\%$ ). No

300 further significant effects were found (main effect of task,  $p=.392$ ,  $BF_{incl} = .273$ ; Group\*Task  
301 interaction,  $p=.185$ ,  $BF_{incl} = .823$ ), suggesting that the behavioural differences between the two  
302 groups were not task-dependent.

303 *Subjective ratings of Emotion and Gender intensity.* Results highlighted a main effect of  
304 emotion ( $F_{(1,10, 41.77)} = 764.861$ ,  $\eta^2 = .955$ ,  $p<.000$ ,  $BF_{incl} = 9.603e+68$ ). Bonferroni corrected  
305 post-hoc pairwise comparisons showed a significant difference between mean ratings of  
306 neutral, fearful and happy expressions (all  $ps <.001$ , all  $BF_{10} > 1.5e+20$ ; neutral:  $M = 49.389$ ,  
307  $SD = 2.975$ ; fearful:  $M = 16.336$ ,  $SD = 8.415$ ; happy:  $M = 87.259$ ,  $SD = 7.797$ ). The two groups  
308 did not show statistically significant differences in how they rated the emotional expressions,  
309 as highlighted by non-significant Group\*Emotion interaction ( $p=.372$ ,  $BF_{incl} = .189$ ) and non-  
310 significant main effect of group ( $p=.519$ ,  $BF_{incl} = .751$ ).

311 Moreover, we found a significant main effect of gender on the pictures ( $F_{(1,36)} = 915.433$ ,  $\eta^2 =$   
312  $.962$ ,  $p=.000$ ,  $BF_{incl} = 1008e+47$ ; female:  $M = 8.466$ ,  $SD = 9.410$ ; male:  $M = 91.995$ ,  $SD =$   
313  $9.586$ ), highlighting a significant difference in how participants rated pictures displaying  
314 female and male individuals. The Task\*Group interaction was also significant ( $F_{(1,36)} = 5.703$ ,  
315  $\eta^2 = .137$ ,  $p=.022$ ,  $BF_{incl} = 18.196$ ). We computed two independent-sample t-tests for female  
316 and male faces. Results suggested a significant difference in how TD and ASD rated male  
317 ( $t(26.074) = -2.600$ ,  $p=.015$ , Cohen's  $d = .603$ ,  $BF_{10} = 3.987$ ; TD:  $M = 95.76$ ,  $SD = 5.51$ ; ASD:  
318  $M = 88.23$ ,  $SD = 11.34$ ), but not female faces ( $p=.064$ ,  $BF_{10} = 1.299$ ).

319

## 320 ***EEG results***

321 *Somatosensory activity (SEP, VEP free) during emotion and gender visual discrimination task*  
322 Somatosensory processing was isolated from concomitant visual activity by subtracting the  
323 visual only condition from the visuo-tactile condition (i.e., visual-tactile minus visual-only

324 trials, see Figure 1B). We only report significant interactions and main effects including the  
325 factors of interest (i.e., group, task, emotion). A summary of findings highlighting group  
326 differences is provided. For the full report of results and description of each analytical step, see  
327 the paragraph ‘Full analysis’.

328

### 329 *Group differences in somatosensory processing of emotional expressions*

330 The analyses of the early SEP components suggested that, during the N80 SEP component,  
331 responses to different emotions varied significantly across sites only in typically developing  
332 participants, as shown by the significant Emotion\*Site interaction in the TD group ( $F_{(2,657, 47.828)}$   
333  $= 4.123$ ;  $\eta^2 = .186$ ;  $p = .014$ ) although this result was not supported by Bayesian statistics  
334 ( $BF_{incl} = .092$ ). In ASD, no interactions or main effects involving the factor emotion were found  
335 (all  $p$ s  $> .05$ , all  $BF_{incl} < .024$ ).

336 During the P100 mid-latency SEP component, results indicated enhanced somatosensory  
337 responses during emotion discrimination task in the TD compared to the ASD group,  
338 particularly in frontal and dorsal regions. This was highlighted by follow-up analyses on  
339 significant Group\*Task\*Region and Group\*Task\*Site interactions (see the paragraph ‘Full  
340 analysis’), revealing enhanced somatosensory responses in TD compared to ASD during  
341 emotion discrimination in the frontal region by both frequentist and Bayesian statistics (two-  
342 tailed independent-sample t-test:  $t(36) = 2.054$ ,  $p = .047$ , Cohen’s  $d = .666$ ,  $BF_{+0} = 3.049$ ) and  
343 the dorsal site (two-tailed independent-sample t-test:  $t(36) = 2.311$ ,  $p = .027$ , Cohen’s  $d = .750$ ,  
344  $BF_{+0} = 4.675$ ). Moreover, the overall activity during emotion task was enhanced in TD  
345 compared to ASD (follow-up on the significant Group\*Task interaction: main effect of group  
346 in emotion task:  $F_{(36, 1)} = 6.51$ ,  $\eta^2 = .15$ ,  $p = .015$ , Bayesian independent-sample t-test:  $BF_{+0} =$   
347  $7.21$ ). All these effects were not-significant for gender task (all  $p$ s  $> .395$ , all  $BF_{10} < .422$ ). In

348 addition, in the TD group, follow-up analyses showed that somatosensory responses were  
349 significantly enhanced for emotion task compared to gender task in the frontal region (two-  
350 tailed paired sample t-test:  $t(18) = 2.166$ ,  $p = .044$ , Cohen's  $d = .497$ ,  $BF_{+0} = 3.044$ ). In the  
351 ASD group, we found no significant differences between somatosensory responses during  
352 emotion and gender task ( $p = .171$ ,  $BF_{+0} = .11$ ). Group differences in the frontal region in SEP  
353 P100 are depicted in Figure 2.

354 Finally, during the N140 SEP component, group differences were primarily apparent in the  
355 right hemisphere, where SEP in response to different emotions varied across tasks in the TD  
356 but not the ASD group. In fact, in TD, we found a significant Task\*Emotion interaction in the  
357 right hemisphere ( $F_{(2,36)} = 3.302$ ;  $\eta^2 = .155$ ,  $p = .048$ ; however,  $BF_{incl} = .11$ ), while no significant  
358 interactions involving the factors task and emotion were found in ASD (all  $ps > .05$ , all  $BF_{incl} <$   
359  $1/3$ ).

360

### 361 *Full analysis*

#### 362 *Early sensitivity of SEPs to emotional expressions in TD (P50, N80)*

363 **P50:** Results highlighted a significant interaction between Group\*Site\*Region ( $F_{(3,19,114,94)}$   
364  $= 3.026$ ;  $\eta^2 = .078$ ;  $p = .030$ ,  $BF_{incl} = .008$ ). We followed-up the Group\*Site\*Region interaction  
365 by performing three mixed repeated-measures ANOVAs for each Region (Frontal, Central,  
366 Parietal) and Site (Dorsal, Dorsolateral, Lateral), but no significant interactions involving the  
367 factor group emerged from this analysis (all  $ps > .05$ , all  $BF_{incl} < 1/3$ ).

368 In this time window, we also found a significant Task\*Emotion\*Hemisphere\*Site\*Region  
369 interaction ( $F_{(5,82,209,36)} = 2.353$ ;  $\eta^2 = .06$ ;  $p = .033$ ). We followed-up this significant interaction  
370 computing two separate mixed repeated-measures ANOVAs for emotion and gender tasks. In  
371 the emotion task, results showed a significant Emotion\*Site\*Region interaction ( $F_{(8, 896)} =$

372 3.026;  $\eta^2 = .076$ ;  $p = .003$ ), although not supported by Bayesian statistics, ( $BF_{incl} = .003$ ). To  
373 follow-up this interaction, we performed an Emotion\*Site repeated-measures ANOVA for  
374 each region (frontal, central and posterior). We found a significant Emotion\*Site interaction in  
375 the frontal region ( $F_{(3,363,124.435)} = 3.148$ ;  $\eta^2 = .078$ ;  $p = .023$ ,  $BF_{incl} = .085$ ; central and posterior  
376 regions, all  $ps > .05$ , all  $BF_{incl} < 1/3$ ) but further follow-up for each site in the frontal region  
377 (dorsal, dorsolateral, lateral) did not reveal significantly different responses to emotional  
378 expressions (Dorsal Site:  $p = .264$ ,  $BF_{incl} = .476$ ; Dorsolateral Site:  $p = .212$ ,  $BF_{incl} = .212$ ; Lateral  
379 Site:  $p = .464$ ,  $BF_{incl} = .078$ ). No significant effects involving the factor emotion were found  
380 when the ANOVA was performed in the Gender Task (all  $ps > .05$ , all  $BF_{incl} < 1$ ).

381 **N80:** The mixed-repeated measures ANOVA highlighted a significant  
382 Group\*Emotion\*Hemisphere\*Site\*Region interaction ( $F_{(5,26, 189.71)} = 2.236$ ;  $\eta^2 = .058$ ;  $p = .049$ )  
383 To follow-up this interaction, we computed two repeated-measures ANOVAs for the ASD and  
384 TD groups including the factors emotion, hemisphere, site and region. In the TD group we  
385 found a significant cross-over interaction between Emotion\*Site ( $F_{(2,657, 47.828)} = 4.123$ ;  $\eta^2 =$   
386  $.186$ ;  $p = .014$ ) although  $BF_{incl}$  highlighted evidence against the inclusion of this interaction in  
387 the model ( $BF_{incl} = .092$ ). Further follow-up running three separate ANOVAs for dorsal,  
388 dorsolateral and lateral sites failed to show statistically significant differences between the  
389 three emotions (Dorsal Site:  $p = .133$ ; Dorsolateral Site:  $p = .796$ ; Lateral Site:  $p = .135$ ; all  $BF_{incl}$   
390  $< 1$ ). No significant interactions involving the factor emotion were found in the ASD group (all  
391  $ps > .05$ , all  $BF_{incl} < .025$ ).

392 In addition, the main ANOVA yielded a significant Emotion\*Site ( $F_{(4,140)} = 5.005$ ;  $\eta^2 = .122$ ;  
393  $p = .000$ ,  $BF_{incl} = .062$ ) interaction. Follow-up analysis on the Emotion\*Site interaction revealed  
394 a main effect of emotion in the dorsal site ( $F_{(2,74)} = 4.340$ ,  $\eta^2 = .104$   $p = .017$ ,  $BF_{incl} = 41.056$ )  
395 and Bonferroni post-hoc test highlighted enhanced responses for fearful compared to happy  
396 expressions ( $p = .013$ ,  $BF_{10} = 6218.018$ , all other  $ps > .05$ , all other  $BF_{10} < 3$ ).

397

398 *Task dependent group differences in somatosensory responses (mid latencies P100, N140)*

399 **P100:** The main ANOVA yielded the following significant interactions involving the between-  
400 factor group: Group\*Task\*Region ( $F_{(1.43, 51.83)} = 4.252$ ;  $\eta^2 = .106$ ,  $p = .031$ ,  $BF_{incl} = .120$ ),  
401 Group\*Task\*Site ( $F_{(1.38, 49.83)} = 4.958$ ;  $\eta^2 = .121$ ,  $p = .020$ ,  $BF_{incl} = 6.526$ ), Group\*Task ( $F_{(1, 36)}$   
402  $= 4.608$ ;  $\eta^2 = .113$ ;  $p = .039$ ,  $BF_{incl} = 28.937$ ). Conversely, main effects of Group ( $p = .066$ ,  $BF_{incl}$   
403  $= .551$ ) and Task ( $p = .647$ ,  $BF_{incl} = .046$ ) were not significant.

404 To understand the Group\*Task\*Region interaction, three separate Group\*Task ANOVAs were  
405 carried out for frontal, central and posterior regions. We found a significant Group\*Task  
406 interaction specific for the frontal region ( $F_{(1,36)} = 6.729$ ,  $\eta^2 = .157$ ,  $p = .014$ ), confirmed by  
407 Bayesian analysis ( $BF_{incl} = 4.143$ ). We computed an independent-sample t-test which  
408 highlighted a significantly enhanced positivity in the TD compared to ASD Group in the  
409 emotion task ( $t(36) = 2.054$ ,  $p = .047$ , Cohen's  $d = .666$ ) but not in the gender task ( $p = .823$ ).  
410 Bayesian independent-sample t-tests were in favour of H1 for emotion task ( $BF_{+0} = 3.049$ ) and  
411 of H0 for gender task ( $BF_{10} = .321$ ) in the frontal region. Moreover, a paired sample t-test  
412 revealed a significantly increased positive response in the emotion task compared to the gender  
413 task in the TD ( $t(18) = 2.166$ ,  $p = .044$ , Cohen's  $d = .497$ ) but not the ASD Group ( $p = .171$ ) in  
414 the frontal region. Bayesian paired-sample t-test was in favour of H1 in the TD group ( $BF_{+0} =$   
415  $3.044$ ) and of H0 ( $BF_{+0} = .11$ ) in the ASD group. No effects involving group and task were  
416 found in the central and posterior regions (all  $ps > .05$ , all  $BF_{incl} < 3$ ).

417 To follow-up the Group\*Task\*Site interaction, three mixed repeated-measures ANOVAs for  
418 the dorsal, dorsolateral and lateral sites were carried out. This analysis revealed a significant  
419 Group\*Task interaction specific for the dorsal site ( $F_{(1,36)} = 6.939$ ,  $\eta^2 = .162$ ,  $p = .012$ ,  $BF_{incl} =$   
420  $4.445$ ), where significant group differences, revealed by independent-sample t-tests, were

421 found in the emotion task ( $t(36) = 2.311$ ,  $p = .027$ , Cohen's  $d = .750$ , Bayesian t-test:  $BF_{+0} =$   
422  $4.675$ ) but not in gender task ( $p = .777$ , Bayesian t-test:  $BF_{10} = .325$ ). Task comparisons carried  
423 out by paired samples t-tests were not significant either in TD and ASD and no significant  
424 effects involving task and/or group were found in other sites (all  $ps > .05$ , all  $BF_{incl} < 3$ ).

425 We also computed two separate mixed repeated-measures ANOVAs for emotion and gender  
426 task, which revealed a main effect of group in the emotion task ( $F_{(36, 1)} = 6.51$ ,  $\eta^2 = .15$ ,  $p = .015$ ;  
427 Bayesian independent-sample t-test:  $BF_{+0} = 7.21$ ). No main effect of group ( $p = .395$ ,  $BF_{incl} =$   
428  $.422$ ) or interactions involving the factor group (all  $ps > .05$ , all  $BF_{incl} < 3$ ) were found in the  
429 gender task.

430 The main ANOVA also yielded an interaction involving the within-factors task and emotion  
431 (Task\*Emotion\*Hemisphere\*Site\*Region ( $F_{(5.52, 198.90)} = 2.68$ ,  $\eta^2 = .069$ ,  $p = .018$ ). We  
432 followed up this interaction computing two repeated-measures ANOVAs for the emotion and  
433 gender tasks, collapsing the between-factor group. Results revealed a significant  
434 Emotion\*Site\*Region interaction specific for the emotion task ( $F_{(4.692, 173.588)} = 2.600$ ,  $\eta^2 = .066$ ,  
435  $p = .030$ ,  $BF_{incl} = .002$ ), but further follow-up breaking by region and by site did not highlight  
436 any significant emotion effect (all  $ps > .05$ , all  $BF_{incl} < 1/3$ ). No interactions or main effects  
437 involving the factor emotion were found in the gender task (all  $ps > .05$ , all  $BF_{incl} < 1/3$ ).

438 **N140:** The analysis revealed a significant Group\*Task\*Emotion\*Hemisphere interaction  
439 ( $F_{(2,72)} = 4.06$ ;  $\eta^2 = .10$ ,  $p = .021$ ), confirmed by Bayesian analysis ( $BF_{incl} = 7.455$ ). To follow-up  
440 this interaction, we computed two repeated measures ANOVAs for the TD and ASD groups  
441 including the factors task, emotion and hemisphere. In the TD group, results revealed a  
442 significant Task\*Emotion\*Hemisphere interaction ( $F_{(2,36)} = 6.596$ ;  $\eta^2 = .268$ ,  $p = .004$ ,  $BF_{incl} =$   
443  $24.544$ ), explained by a crossover interaction between task and emotion in the right hemisphere  
444 ( $F_{(2,36)} = 3.302$ ;  $\eta^2 = .155$ ,  $p = .048$ ,  $BF_{incl} = 1.188$ ). Further follow-up on the Task\*Emotion

445 interaction, performed computing two separate repeated measures ANOVAs for emotion and  
446 gender tasks, did not show statistically significant differences between the three emotions (all  
447  $ps >.05$ , all  $BF_{incl} < 3$ ). In the ASD group, the repeated-measures ANOVA involving the factors  
448 task, emotion and hemisphere didn't yield any significant interaction of main effect involving  
449 task or emotion (all  $ps >.05$ , all  $BF_{incl} < 1/3$ ).

450 The main ANOVA also yielded a significant Task\*Emotion\*Hemisphere\*Site\*Region  
451 interaction ( $F_{(8,288)}=2.09$ ;  $p\eta^2=.05$ ,  $p=.037$ ). To follow it up, we ran two repeated-measures  
452 ANOVAs for emotion and gender tasks separately. Results showed no significant interactions  
453 involving the factor emotion in the emotion task (all  $ps >.05$ , all  $BF_{incl} < 1/3$ ). A significant  
454 Emotion\*Hemisphere\*Site\*Region interaction ( $F_{(8,296)}=2.167$ ;  $p\eta^2=.055$ ,  $p=.030$ ) was found in  
455 the gender task, however, Bayesian statistics highlighted strong evidence against models  
456 including this interaction ( $BF_{incl} = .003$ ). Further follow-up analysis breaking the interaction  
457 by hemisphere, site and region did not show significant interactions involving the factor  
458 emotion (all  $ps >.05$ , all  $BF_{incl} < 1/3$ ).

459

#### 460 *Linear relationships between personality traits and SEP amplitudes*

461 The correlation analyses among personality traits revealed significant correlations between  
462 autistic traits (measured with SRS-2 and AQ), alexithymia (TAS-20) and interoceptive  
463 awareness (MAIA-2) in the whole sample of participants (all  $ps < .02$ , all  $BF > 3$ ). Interestingly,  
464 in the ASD group, autistic traits and alexithymia were not correlated (all  $ps > .5$ ; all  $BF < 1/2$ ),  
465 while both SRS-2 and AQ were significantly correlated with MAIA-2 (all  $ps < .02$ , all  $BF >$   
466  $3$ ). For a summary of these results, see Table 2A (whole sample) and 2B (ASD group).

467 We then ran correlations between personality traits and SEP amplitudes. We focused on the  
468 P100 component, where significant group differences were highlighted by t-tests. We

469 computed correlations between participants' scores on Social Responsiveness Scale (SRS-2),  
470 Autism Quotient (AQ), Toronto Alexithymia Scale (TAS-20) and Multidimensional  
471 Assessment of Interoceptive Awareness (MAIA-2) and mean SEP amplitudes in all the clusters  
472 of electrodes where significant between-group differences were found (frontal SEP amplitudes  
473 (mean activity of 6 electrodes over frontal sensorimotor regions), mean SEP amplitudes (mean  
474 activity of 18 electrodes over sensorimotor regions), dorsal SEP amplitudes (mean activity of  
475 6 electrodes over sensorimotor areas close to the midline). Interestingly, autistic traits measured  
476 both by the Social Responsiveness Scale (SRS-2) and the Autism Quotient (AQ) were highly  
477 correlated with SEP amplitudes evoked during the emotion task in all clusters of electrodes (all  
478  $p$ s  $<.006$ , all  $BF_{0-} > 18.413$ ), see Table 3. Conversely, correlation between SRS-2 and AQ  
479 scores and somatosensory activity evoked during the gender task was not significant in almost  
480 every electrode cluster. These results highlight a strong and persistent relationship between  
481 patterns of somatosensory responses evoked during the emotion discrimination task and  
482 autistic traits. Interoceptive awareness was also significantly correlated with the activity  
483 evoked during the emotion task (all  $p$ s  $<.015$ , all  $BF_{0+} > 8.188$ ) but not gender task (all  $p$ s  $>.35$ ,  
484 all  $BF_{0+} < .5$ ) in all clusters of electrodes. Alexithymia did not show a significant relationship  
485 with SEP amplitudes in emotion task (all  $p$ s  $>.120$ , all  $BF_{0-} < 3$ ). For a graphical representation  
486 of correlations between frontal SEP amplitudes and personality traits, see Figures 3 (emotion  
487 task) and 4 (gender task).

488 To further explore the relationship between clinical features of autism and somatosensory  
489 processing of emotional expressions, we ran the same analysis including the ASD group only.  
490 Results of the correlations confirmed the patterns observed in the whole sample of participants,  
491 showing significant correlations between individual scores on SRS-2 and AQ and SEP  
492 amplitudes specific for the emotion task. Furthermore, the analysis confirmed that Alexithymia  
493 was not significantly correlated with SEP amplitudes in any cluster and task (all  $p$ s  $>.25$ , all

494  $BF_{0-} < .80$ ) and interoceptive awareness was not significantly correlated with SEP amplitudes  
495 (all  $ps > .07$ , all  $BF_{0+} < 3$ ) (see Table 4 for full results).

496 In addition, we wanted to test if the individual scores on the personality questionnaires could  
497 significantly predict SEP amplitudes in the frontal region, where compelling patterns of group  
498 differences were observed. We ran multiple linear regressions using the backward method with  
499 SRS-2, AQ, TAS-20 and MAIA-2 as predictors of SEP P100 amplitudes evoked during the  
500 emotion and gender tasks. In the emotion task, the analysis yielded a highly significant model  
501 ( $F_{(1,30)} = 15.369$ ,  $p = .000$ ,  $R^2 = .339$ ,  $BF_{10} = 57.092$ ; SEP amplitude decreased  $.036 \mu V$  for each  
502 +1 score). The model had AQ as a single predictor. This is explained by the highly significant  
503 correlations between questionnaires' scores (see Table 2A), which generated collinearity  
504 between predictors. In the gender task, the same model was not significant ( $p = .051$ ,  $BF_{10} =$   
505  $1.553$ ).

506 We ran the same multiple linear regression on the ASD group, and the pattern observed in the  
507 whole sample was confirmed. We found a significant model for the emotion task ( $F_{(1,14)} = 5.210$ ,  
508  $p = .039$ ,  $R^2 = .271$ ,  $BF_{10} = 2.629$ , SEP amplitude decreased  $.062 \mu V$  for each +1 score) with AQ  
509 as a single predictor. Again, this is explained by the highly significant correlation between  
510 questionnaires' scores in ASD (see Table 2B). We ran another linear regression with the same  
511 predictors for the gender task, but also in this case the model was not significant ( $p = .220$ ,  $BF_{10}$   
512  $= .734$ ).

513

#### 514 *Source Reconstruction*

515 The best model for the TD group was the source reconstruction on 300 ms segment (log-  
516 evidence  $-1715.8$ , difference with the second best model  $= 311.9$ ). The winning model for the  
517 ASD group was the source reconstruction on 200 ms (log evidence  $-1443.2$ , difference  $6.2$ ).

518 Both models showed strong evidence compared to the others because the difference in log  
519 evidence was  $> 50$  (Ranlund et al., 2016).

520 **P50:** The main source of activity at 50 ms was localised in the right primary somatosensory  
521 cortex (S1) in both tasks for TD (coordinates: 46, -29, 54 for both tasks) and ASD (coordinates:  
522 emotion task: 42, -35, 58; gender task: 46, -31, 57).

523 **N80:** The primary source at 90 ms was located in right Brodmann Area (BA) 6 (coordinates:  
524 12, -18, 71) for both groups and tasks. Active voxels were localised also in the right primary  
525 (S1) and secondary (S2) somatosensory cortices and in left BA6.

526 **P100:** For the TD group, the main source at 110 ms was localised in BA 6 (coordinates: 12, -  
527 18, 71 in both tasks) For the ASD group, the main source was localised in BA 6 (emotion task:  
528 12, -18, 71; gender task: 14, -20, 69). Other active voxels were localised in the primary (S1)  
529 and secondary (S2) somatosensory cortices, right M1, left BA 6 and bilateral prefrontal areas  
530 (BA 46) for both tasks and groups. Brain maps from P100 source reconstruction of evoked  
531 activity during the emotion task can be visualised in Figure 2 D.

532 **N140:** In the TD group, for the emotion task the main source at 145 ms was localised in the  
533 right BA 6 (coordinates: 12, -18, 71), and for the gender task in BA 20 (coordinates 52, -14, -  
534 30). In the ASD group, for the emotion task the main source was localised in BA 6 (coordinates  
535 60, -1, 22) and for the gender task in BA 20 (coordinates 52, -14, -30). Other active voxels  
536 were localised in the primary (S1) and secondary (S2) somatosensory cortices and the bilateral  
537 prefrontal cortex (BA 46) for both tasks and groups.

538

539 *Visual activity (VEP) during emotion and gender visual discrimination task.*

540 Visual activity evoked in the visual-only condition (VOC) was analysed. A summary of  
541 findings involving group differences is provided, for the full report of results (involving factors  
542 group, task, and/or emotion) and description of each analytical step, see the paragraph ‘Full  
543 analysis’.

544

#### 545 *Group differences in visual processing of emotional expressions*

546 In the P120 VEP component, the analysis revealed modulations of visual responses associated  
547 with different emotional expressions in the TD group, as shown by the significant  
548 Emotion\*Electrode interaction in the right hemisphere ( $F_{(2,72)}=3.082$ ;  $p\eta^2=.146$ ,  $p=.021$ ,  
549 however  $BF_{incl} = .027$ ). In the ASD group, no interactions or main effects involving the factor  
550 emotion were found (all  $ps >.05$ , all  $BF_{incl} < 1/3$ ).

551 In the N170 component, ASD individuals showed significantly reduced visual responses during  
552 emotion processing compared to gender, as revealed by follow-up analysis on the significant  
553 Task\*Group interaction (main effect of task in ASD group:  $F_{(1,18)} = 7.162$ ;  $p\eta^2=.285$ ;  $p=.015$ ,  
554  $BF_{10} = 3.639$ ). No significant task-related differences were found in TD ( $p=.541$ ) and no  
555 between group differences were revealed by independent-sample t-tests (all  $ps >.70$ , all  $BF_{incl}$   
556  $< 1/3$ ).

557

#### 558 *Full analysis*

559 **P120:** Results from the mixed repeated measures ANOVA showed the following significant  
560 interactions: Group\*Emotion\*Hemisphere\*Electrode ( $F_{(4,144)}=3.613$ ;  $p\eta^2=.091$ ;  $p=.008$ ,  $BF_{incl}$   
561  $= .027$ ). Task\*Emotion\*Hemisphere ( $F_{(2,72)} = 6.955$ ;  $p\eta^2=.161$ ;  $p=.002$ ,  $BF_{incl} = .103$ ),  
562 Task\*Emotion\*Electrode ( $F_{(2.90,104.25)}=3.651$ ;  $p\eta^2=.092$ ,  $p=.016$ ,  $BF_{incl} = .019$ ). To follow-up

563 the Group\*Emotion\*Hemisphere\*Electrode interaction, we computed two separate repeated-  
564 measures ANOVAs for TD and ASD groups collapsing the factor task and we found a  
565 significant Emotion\*Hemisphere\*Electrode interaction ( $F_{(4,72)}=2.998$ ;  $p\eta^2=.023$ ;  $p=.024$ ,  $BF_{incl}$   
566  $= .019$ ) in the TD group. No significant interactions were found in the ASD group (all  $ps > .05$ ,  
567 all  $BF_{incl} < 1/3$  ). We computed two separate repeated-measures ANOVAs for left and right  
568 hemispheres only in TD and we found a significant Emotion\*Electrode interaction  
569 ( $F_{(2,72)}=3.082$ ;  $p\eta^2=.146$ ,  $p=.021$ ,  $BF_{incl} = .018$ ) in the right hemisphere. We computed three  
570 separate one-way ANOVAs for the three electrodes (O2, O10, PO10) but no main effects of  
571 emotion were found (all  $ps >.05$ , all  $BF_{incl} < 1/3$  ). No significant interactions including the  
572 factor emotion were found in the left hemisphere (all  $ps >.05$ , all  $BF_{incl} < 1/3$  ).

573 Moreover, we followed up the Task\*Emotion\*Hemisphere and Task\*Emotion\*Electrode  
574 interactions computing two mixed repeated-measures ANOVA for the emotion and gender  
575 task. Results highlighted significant Emotion\*Hemisphere ( $F_{(1,60,59,50)}=5.316$ ;  $p\eta^2=.125$ ;  
576  $p=.012$ ,  $BF_{incl} = .379$ ) and Emotion\*Electrode ( $F_{(2,52,93,35)} =4.645$ ;  $p\eta^2=.112$ ;  $p=.007$ ,  $BF_{incl} =$   
577  $.019$ ) interactions in the emotion task. We computed two repeated-measures ANOVAs  
578 breaking emotion task by hemisphere and we found a significant Emotion\*Electrode  
579 interaction in the right hemisphere ( $F_{(2,71,10,31)}= 4.707$ ;  $p\eta^2=.113$ ;  $p=.005$ ,  $BF_{incl} = .040$ ). A  
580 significant main effect of emotion was found in electrode O2 ( $F_{(2,72)}=3.841$ ;  $p\eta^2=.094$   $p=.026$ ,  
581  $BF_{incl} = 1.744$ ) and Bonferroni post-hoc test revealed increased positivity for happy expression  
582 compared to fearful ( $p=.022$ ,  $BF_{10} = 18.830$ ). No significant interactions involving the factor  
583 emotion were found in the gender task (all  $ps > .05$ , all  $BF_{incl} < 1/3$  ). These results suggesting  
584 increased sensitivity of the right occipital visual areas during early stages of emotion  
585 discrimination.

586 **N170:** We found these significant interactions involving the factor group: Task\*Group ( $F_{(1,36)}$   
587  $= 4.76$ ;  $p\eta^2=.121$ ;  $p=.04$ ,  $BF_{incl} = 9.093$ ), Task\*Hemisphere\*Electrode\*Group ( $F_{(2,72)} = 3.988$ ;

588  $p\eta^2=.098$ ,  $p=.04$   $BF_{incl} = .104$ ). We followed-up the Task\*Group interaction computing two  
589 repeated-measures ANOVAs for TD and ASD groups comparing VEP amplitudes in emotion  
590 and gender tasks. We found significantly decreased negativity for emotion task compared to  
591 gender task in the ASD group ( $F_{(1,18)} = 7.162$ ;  $p\eta^2 = .285$ ;  $p=.015$ ; Bayesian paired-sample t-  
592 test:  $BF_{10} = 3.639$ ). No significant differences were found in the TD group ( $p=.541$ , Bayesian  
593 paired-sample t-test:  $BF_{10} = .282$ ). Moreover, independent-sample t-tests did not reveal  
594 significant group differences (all  $p>.05$ ; Bayesian t-test: emotion task:  $BF_{10}= 1/3$ ; gender task:  
595  $BF_{10}= .317$ ). These results are described in Figure 5.

596 Follow-up analysis on the Task\*Hemisphere\*Electrode\*Group (computed breaking for left  
597 and right hemispheres) revealed significant Task\*Group interaction in the right hemisphere,  
598 electrodes PO10 of the 10/10 system ( $F_{(1,36)} = 11.279$ ;  $p\eta^2 = .239$ ,  $p=.002$ ,  $BF_{incl} = 451.38$ ) and  
599 P10 ( $F_{(1,36)} = 5.562$ ;  $p\eta^2 = .134$ ;  $p=.024$ ,  $BF_{incl} = 37.465$ ). Paired sample t-tests revealed  
600 significant task differences in ASD group in electrode PO10 ( $t(18)=3,373$ ,  $p=.003$ , Cohen's d  
601  $= .774$ ,  $BF_{10} = 12.933$ ) and P10 ( $t(18)=2,821$ ,  $p=.011$ , Cohen's d  $= .647$ ,  $BF_{0+} = 4.693$ ), both  
602 showing increased negativity for the gender task. No differences were found in the TD group  
603 and independent-sample t-tests did not show significant between-groups differences (all  $p$   
604  $>.05$ , all  $BF < 1/3$ ).

605 Moreover, we found the following significant interaction and main effects involving the factor  
606 emotion: Task\*Emotion\*Electrode ( $F_{(3,41,123.07)} = 3.02$ ;  $p\eta^2=.08$ ;  $p=.02$ ,  $BF_{incl} = .010$ ),  
607 Hemisphere\*Emotion ( $F_{(2,72)} = 5.75$ ;  $p\eta^2=.14$ ;  $p=.005$ ,  $BF_{incl} = .050$ ), Electrode\*Emotion  
608 ( $F_{(2,90,104.62)} = 8.48$ ;  $p\eta^2=.19$ ;  $p=.000$ ,  $BF_{incl} = .012$ ), and a main effect of emotion ( $F_{(2,72)} = 21.90$ ;  
609  $p\eta^2=.38$ ;  $p=.000$ ,  $BF_{incl} = 4552e+7$ ).

610 To follow-up the Task\*Emotion\*Electrode interaction, we collapsed over groups and  
611 computed two repeated-measures ANOVAs for emotion and gender tasks. Main effect of

612 emotion was significant in emotion task ( $F_{(2,72)} = 14.217$ ;  $\eta^2=.278$ ;  $p=.000$ ,  $BF_{incl} = .304$ ) and  
613 gender task ( $F_{(2,72)} = 9.933$ ;  $\eta^2=.216$ ;  $p=.000$ ,  $BF_{incl} = 2178.310$ ). Moreover we found a  
614 significant Electrode\*Emotion interaction in the emotion ( $F_{(2,72)} = 4.369$ ;  $\eta^2=.106$ ;  $p=.002$ ,  
615  $BF_{incl} = 5749.421$ ) and gender tasks ( $F_{(2,72)} = 6.597$ ;  $\eta^2=.155$ ;  $p=.000$ ,  $BF_{incl}=.023$ ). A  
616 significant main effect of emotion was found in all electrode positions: Emotion Task: O1/2:  
617  $F_{(2,74)} = 5.395$ ;  $\eta^2=.127$   $p = .007$ ,  $BF_{incl} = .281$ , Post-hoc (Bonferroni corrected): lower  
618 amplitude for neutral compared to fearful,  $p=.031$ ,  $BF_{10} = 17.966$  and happy,  $p=.010$ ,  $BF_{10} =$   
619  $29.232$ ; Electrodes O9/10:  $F_{(2,74)} = 15.052$ ;  $\eta^2=.289$ ,  $p = .000$ ,  $BF_{incl} = 4351.505$ ), Post-hoc  
620 (Bonferroni corrected): lower amplitude for neutral compared to fearful,  $p=.000$ ,  $BF_{10} =$   
621  $138047.127$  and happy,  $p=.000$ ,  $BF_{10} = 4.786e+6$ ; O9/10:  $F_{(2,74)} = 15.737$ ;  $\eta^2=.290$ ,  $p = .000$ ,  
622  $BF_{incl} = 9.986$ ; post-hoc (Bonferroni corrected): increased negativity for fearful ( $p = .000$ ,  $BF_{10}$   
623  $= 435624.724$ ) and happy ( $p=.000$ ,  $BF_{10} = 262931.299$ ) compared to neutral; Gender Task:  
624 O1/2:  $F_{(2,74)} = 3.968$ ;  $\eta^2=.097$   $p = .025$ ,  $BF_{incl} = .269$ , Post-hoc (Bonferroni corrected): lower  
625 amplitude for neutral compared to fearful,  $p=.040$ ,  $BF_{10} = 29.435$ ; Electrodes O9/10:  $F_{(2,74)} =$   
626  $8.892$ ;  $\eta^2=.194$ ,  $p = .001$ ,  $BF_{incl} = 293.330$ ), Post-hoc (Bonferroni corrected): increased  
627 negativity for fearful compared to neutral ( $p=.001$ ,  $BF_{10} = 56614.605$ ) and happy ( $p=.048$ ,  $BF_{10}$   
628  $= 28.074$ ); electrodes O9/10:  $F_{(2,74)} = 13.825$ ;  $\eta^2=.272$ ,  $p = .000$ ,  $BF_{incl} = 31.280$ ; post-hoc  
629 (Bonferroni corrected): increased negativity for fearful compared to neutral ( $p = .000$ ,  $BF_{10} =$   
630  $533077.721$ ) and happy ( $p=.005$ ,  $BF_{10} = 413.951$ ).

631 To explore the Hemisphere\*Emotion interaction, we collapsed tasks, groups and electrodes  
632 and broke the ANOVA by hemisphere. Results highlighted a main effect of emotion in the left  
633 hemisphere ( $F_{(2,74)} = 14.431$ ;  $\eta^2=.281$ ;  $p=.000$ ,  $BF_{10} = 22.575$ ), Post-hoc (Bonferroni  
634 corrected) revealed increased negativity for fearful compared to neutral ( $p=.000$ ,  $BF_{10} =$   
635  $2.548e+12$ ) and happy ( $p=.021$ ,  $BF_{10} = 295.096$ ), and for happy compared to neutral ( $p=.049$ ,  
636  $BF_{10} = 283.516$ ). Main effect of emotion was found also in the right hemisphere ( $F_{(2,74)} =$

637 23.429;  $\eta^2 = .3888$ ,  $p = .000$ ,  $BF_{10} = 117.131$ ) and post-hoc (Bonferroni corrected) increased  
638 negativity for fearful compared to neutral ( $p = .000$ ,  $BF_{10} = 3.406e+14$ ) and happy compared to  
639 neutral ( $p = .000$ ,  $BF_{10} = 1.307e+14$ ).

640 Finally, Bonferroni corrected pairwise comparisons on the main effect of emotion revealed  
641 increased negativity for fearful ( $p = .000$ ,  $BF_{10} = 1.293e+28$ ) and happy ( $p = .000$ ,  $BF_{10} =$   
642  $2.336e+15$ ) expressions compared to neutral expressions.

643 **P250:** In this time window, we found no significant interactions or main effects involving the  
644 factor group. Results exhibited significant Task\*Emotion ( $F_{(2,72)} = 4.87$ ;  $\eta^2 = .11$ ,  $p = .01$ ,  $BF_{incl}$   
645  $= .314$ ), and Emotion\*Electrode ( $F_{(4,144)} = 8.76$ ;  $\eta^2 = .19$ ,  $p = .000$ ,  $BF_{incl} = .009$ ) interactions  
646 and a main effect of emotion ( $F_{(2,72)} = 3.30$ ;  $\eta^2 = .08$ ,  $p = .04$ ,  $BF_{incl} = .018$ ). Follow-up on the  
647 Task\*Emotion interaction, performed breaking by task the main mixed repeated-measure  
648 ANOVA, revealed a main effect of emotion in the gender task ( $F_{(2,74)} = 3.921$ ;  $\eta^2 = .096$ ;  
649  $p = .024$ ,  $BF_{incl} = 1.151$ ). Bonferroni post-hoc test did not reveal significant pairwise  
650 comparisons. Nevertheless, uncorrected post-hoc test highlighted significant reduced positivity  
651 for fearful compared to neutral ( $p = .039$ ,  $BF_{10} = 27.853$ ) and happy ( $p = .022$ ,  $BF_{10} = 5991.424$ )  
652 expressions. Moreover, we ran a follow-up analysis on the Emotion\*Electrode interaction  
653 computing three repeated-measures ANOVAs for the three electrode positions and we found a  
654 main effect of emotion in electrodes PO9/10 ( $F_{(2,74)} = 7.341$ ;  $\eta^2 = .166$ ,  $p = .001$ ,  $BF_{incl} = 1.924$ );  
655 post-hoc (Bonferroni corrected) revealed a decreased positivity for fearful compared to neutral  
656 ( $p = .003$ ,  $BF_{incl} = 1285.724$ ) and happy ( $p = .036$ ,  $BF_{incl} = 1.505$ ). Finally, post-hoc test  
657 (Bonferroni corrected) on the main effect of emotion revealed a significantly increased positive  
658 amplitude for neutral compared to fearful expressions ( $p = .020$ ,  $BF_{10} = 2.630e+6$ ).

659

660 *Correlations: Personality Traits and VEPs*

661 Correlations were computed between SRS-2, AQ, TAS-20, MAIA-2 and the VEP N170  
662 amplitudes, where significant group and task interactions were found. We collapsed 6  
663 electrodes over occipital areas. Results highlighted that VEP amplitudes were not significantly  
664 correlated with any of the questionnaires (all  $p$ s  $>.1$ , all  $BF < 1$ ). We ran the same analysis on  
665 the ASD group only and we found a significant correlation between TAS – 20 and VEP  
666 amplitudes in emotion task ( $N = 19$ ,  $r = -.565$ ,  $p=.012$ ,  $BF_{10} = 5.446$ ) and gender task ( $N = 19$ ,  
667  $r = -.528$ ,  $p=.020$ ,  $BF_{10} = 3.246$ ).

668

## 669 **Discussion**

670 The role of the somatosensory system in re-enacting the somatic patterns associated with the  
671 observed emotional expressions is well-established in the neurotypical population (Adolphs et  
672 al., 2000; Pitcher et al., 2008; Sel et al., 2014). Nevertheless, the hypothesis of reduced  
673 embodiment of emotional expressions in individuals with ASD is poorly investigated. In this  
674 study, we assessed the dynamics of somatosensory activity during emotion processing over and  
675 above differences in visual responses in two groups of ASD and typically developing  
676 participants. By evoking task-irrelevant SEPs, we probed the state of the somatosensory system  
677 during a visual emotion discrimination task and a control gender task. Moreover, we  
678 dissociated somatosensory from visual activity by subtracting VEPs from SEPs (Galvez-Pol et  
679 al., 2020), and compared pure somatosensory responses in ASD and TD during emotion and  
680 gender perception. We hypothesised that the two groups would differently modulate their SEPs  
681 in the emotion task but not in the gender task. Results were in line with our predictions and  
682 provided the first empirical evidence of reduced activations of the somatosensory cortex during  
683 observation and discrimination of facial emotional expressions in autistic individuals. This  
684 result is coherent with hierarchical models of face perception (Haxby et al., 2000; Calder and  
685 Young, 2005) indicating that systems beyond the visual one contribute in mapping changeable  
686 features of the observed face, such as its motion, emotion, direction of gaze, as supported by

687 studies on prosopagnosic patients or brain stimulation studies, indicating the contribution of  
688 areas other than the fusiform and of the Superior Temporal Sulcus in facial emotion processing  
689 (Moro et al., 2012; Candidi et al., 2015).

690 Our main finding concerns enhanced responses of the somatosensory system during emotion  
691 processing in typically developed individuals compared to autistic individuals in the P100 SEP  
692 component, during emotion but not gender discrimination. This pattern is consistent with TMS  
693 evidence showing sequential recruitment of visual and somatosensory areas during emotion  
694 processing (Pitcher et al., 2008). Group differences in somatosensory responses were  
695 systematically observed in the frontal sensorimotor region, in the dorsal sites, and in the overall  
696 activity. Specifically, the ASD group showed reduced P100 amplitudes compared to the TD  
697 only during emotion processing, revealing reduced embodiment of emotional expressions in  
698 ASD. Moreover, in the TD group, but not in ASD, we observed significantly increased P100  
699 amplitudes during emotion compared to gender recognition, suggesting stronger engagement  
700 of the somatosensory system during emotion compared to gender processing in the typical  
701 population, but not in autistic individuals. Importantly, in the behavioural emotion and gender  
702 recognition task, the ASD group showed overall decreased accuracy in catch trials compared  
703 to TD; however, these behavioural differences were independent from the task. This suggests  
704 that the observed task-related group differences in somatosensory responses cannot be simply  
705 explained as reduced attention or poor behavioural performance during emotion discrimination  
706 in ASD compared to TD.

707 Task-dependent group differences were also found in the N140 SEP component. Here, we  
708 observed task-specific patterns of responses to different emotions in TD individuals which  
709 were absent in ASD, suggesting persistent recruitment of the somatosensory system during  
710 emotion discrimination only in the neurotypical group. This effect was localised in the right  
711 hemisphere, consistently with previous literature (Adolphs et al., 2000; Pitcher et al., 2008).

712 Conversely, in the early stages of emotion processing, results suggested that the two groups  
713 might be characterised by general emotion-related differences (N80).

714 Importantly, we provided further evidence on the relationship between autism and atypical  
715 recruitment of the somatosensory system during emotion discrimination in mid-latency stages  
716 of emotion processing. In fact, autistic traits measured by two different questionnaires (SRS-2  
717 and AQ) strongly correlated with P100 amplitudes in all the clusters of electrodes where  
718 significant between-group differences were observed. Importantly, only SEP amplitudes  
719 evoked during the emotion task were significantly correlated with autistic traits. The  
720 relationship between autistic traits and somatosensory activity during emotion processing was  
721 further confirmed by the multiple linear regressions. Here we observed that the strength of  
722 autistic traits, but not alexithymia, was a significant predictor of SEP amplitudes. The  
723 regression model was significant only for the emotion task, and SEP amplitudes were predicted  
724 both in the whole sample (considering clinical and subclinical autistic traits as a continuum,  
725 see Bölte et al., 2011, Constantino & Todd, 2003, 2005; Ruzich et al., 2015) and in the ASD  
726 group alone. These results highlight a persistent linear relationship between the strength of  
727 autistic traits and the levels of embodiment of visually perceived emotions.

728 Crucially, alexithymia traits (measured by TAS-20) were not associated with enhanced  
729 somatosensory responses, suggesting that reduced recruitment of the somatosensory system  
730 during emotion discrimination is related to autism rather than alexithymia, which is often  
731 associated with ASD. This result suggests that not all facets of emotion-related processing  
732 difficulties observed in ASD can be attributed to co-occurring alexithymia as some have  
733 suggested (Bird & Cook, 2013; Cook et al., 2013). Interestingly, interoceptive awareness was  
734 correlated with emotional embodiment, which is in line with evidence implicating the insular  
735 cortex in the emotion processing difficulties associated with autism (Silani et al., 2008; Ebisch  
736 et al., 2011). Nevertheless, the correlation between interoceptive awareness and emotional

737 embodiment was significant only when the full cohort was considered in the analysis.  
738 Conversely, no significant association between somatosensory embodiment and interoceptive  
739 awareness was found when considering the ASD group only. While this discrepancy might  
740 arise as a consequence of smaller sample size, it is also possible that our results reflect a general  
741 association between interoception and somatosensory embodiment of emotions (and not  
742 specifically related to ASD). This pattern of findings contributes to a growing literature, which  
743 suggests that alexithymia and interoception may play distinct but interacting roles in the  
744 emotion processing difficulties associated with ASD (e.g., Gaigg et al., 2016; Garfinkel et al.,  
745 2016; Poquérousse et al., 2018; Nicholson et al., 2018).

746 Source reconstruction on the SEP components of interest revealed sources of activity in  
747 primary and secondary right somatosensory cortices and right BA6. This is consistent with  
748 evidence showing distributed cortical sources of SEP (Hari, et al., 1983; Harnilainen et al.,  
749 1990; Allison et al., 1992; Dowman & Darcey, 1994; Allison et al., 1996; Mauguière et al.,  
750 1997; Nakamura et al., 1998; Klingner et al., 2011; 2015).

751 Overall, these patterns of responses reveal a decreased engagement of the somatosensory  
752 system during emotion processing in ASD compared to typical participants. These results are  
753 in line with previous literature suggesting decreased vicarious representations of others' bodily  
754 states in ASD (Grèzes et al., 2008; Minio-Paluello et al., 2009; Masson et al., 2019). According  
755 to recent accounts, atypical top-down modulations of vicarious sensorimotor activity could be  
756 implicated in reduced embodied simulation (Hamilton et al., 2013) and sensory processing  
757 (Cook et al., 2012) in ASD. Therefore, it is possible that differential somatosensory responses  
758 in mid-latency components in ASD and TD (P100 and N140) are driven by atypical top-down  
759 modulations from high-order frontal areas. This hypothesis is in line with evidence showing  
760 that SEP amplitudes, especially mid-latency components, are modulated by top-down  
761 mechanisms (Josiassen et al., 1982; Michie et al., 1987; Desmedt & Tomberg, 1989; Eimer et

762 al., 2005; Forster & Eimer, 2005). Moreover, it is consistent with recent accounts, suggesting  
763 that somatosensory processing is implemented in a distributed neural system (de Haan &  
764 Dijkerman, 2020; Saadon-Grosman et al., 2020)

765 Importantly, our results cannot be explained in terms of carry-over effects from atypical visual  
766 processing in ASD. Through subtractive methods (Dell'acqua et al., 2003), we isolated  
767 somatosensory activity from visual evoked potentials and highlighted pure somatosensory  
768 responses over and above visual activity. Moreover, the analysis of VEPs did not show the  
769 same patterns of between-group differences we observed in SEPs, therefore it is unlikely that  
770 reduced embodiment is driven by cascade effects of atypical visual responses. Instead, our  
771 results suggest a specific role of the somatosensory system in triggering atypical emotion  
772 processing in ASD. In the visual N170 component, possibly arising concurrently to  
773 somatosensory processing (Pitcher et al., 2008), we observed task-related differences only in  
774 the ASD group, resulting in reduced responses during emotion recognition tasks compared to  
775 the gender task. This might underlie reduced activations of visual areas during emotion  
776 perception in ASD, as also suggested by previous studies (Kang et al., 2018; Martínez et al.,  
777 2019). Interestingly, the amplitudes of the N170 component correlated with the strength of  
778 alexithymic traits, but not autistic traits, in the ASD group, partly contradicting previous results  
779 (Desai et al., 2019) and suggesting a possible dissociation between atypical somatosensory and  
780 visual facial emotion processing related to autistic and alexithymia traits in ASD. Future  
781 research will have to systematically test this hypothesis to confirm this finding.

782 Our study provides novel data on atypical recruitment of the somatosensory system during  
783 emotion discrimination in ASD, suggesting reduced embodiment of the observed expressions  
784 independently from visual processing. These results offer a novel perspective on the neural  
785 dynamics underlying emotion discrimination in ASD, consistent with a theoretical framework

786 proposing that difficulties of autistic individuals in the domain of social cognition are tied to  
787 reduced vicarious representations of others' bodily states.

788 **Tables and Figures**

789 **Table 1.** *Demographics and questionnaires scores for Autism Spectrum Disorder (ASD) and Typically*  
 790 *Developing (TD) participants.*

791 VIQ: Verbal Intelligence Quotient; PIQ: Performance Intelligence Quotient; SRS-2: Social  
 792 Responsiveness Scale; AQ: Autism Quotient; TAS-20: Toronto Alexithymia Scale; MAIA-2:  
 793 Multidimensional Assessment of Interoceptive Awareness (mean ± standard deviation).

794 \*p<.05; \*\*p<.01

795

	<b>TD</b>	<b>ASD</b>	<b>Results</b>	<b>Cohen's d</b>	<b>BF<sub>10</sub></b>
<i>Age</i>	40.84 ± 12.24	40.47 ± 8.86	t(36) = .11, p=.92	.034	.316
<i>VIQ</i>	113.58 ± 17.80	108.56 ± 15.38	t(35) = .92, p=.37	.301	.442
<i>PIQ</i>	117.42 ± 13.98	111.17 ± 14.75	t(35) = 1.32, p=.194	.434	.629
<i>SRS-2</i>	49.29 ± 5.91	69.12 ± 11.37	t(32) = -6.39, p=.000**	2.188	30200
<i>AQ</i>	17.61 ± 8.79	34.89 ± 7.76	t(34) = -6.25, p=.000**	2.084	27800
<i>TAS-20</i>	40.42 ± 8.76	54.33 ± 14.19	t(36) = -3.63, p=.000**	1.178	34.9794
<i>MAIA -2</i>	3.15 ± .68	2.65 ± .81	t(36) = -3.44, p=.048*	.664	1.566

796

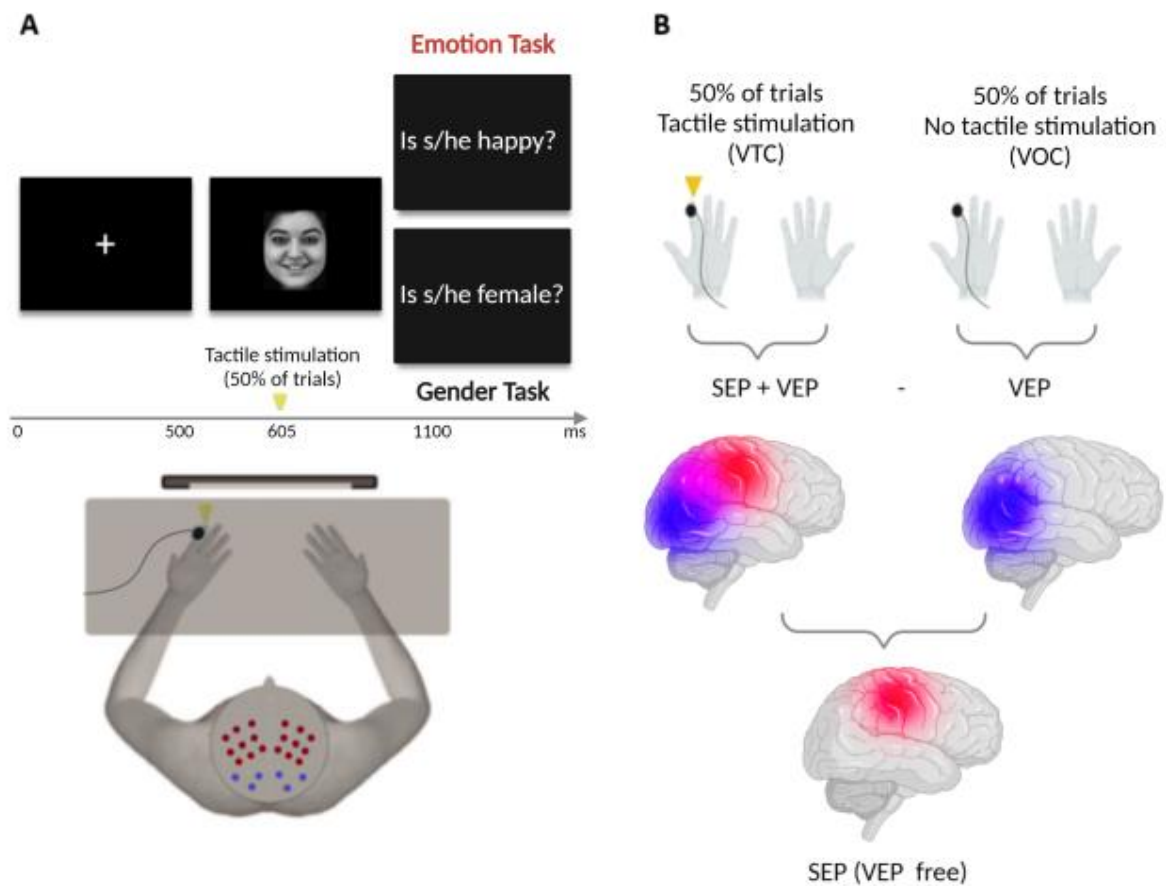
797 **Table 2.** *Correlations between questionnaires scores A. in the whole sample of participants and B. in*  
 798 *the ASD group.*

799 SRS-2: Social Responsiveness Scale, Second Edition; AQ: Autism Quotient; TAS-20: Twenty-Item  
 800 Toronto Alexithymia scale; MAIA-2: Multidimensional Assessment of Interoceptive Awareness,  
 801 Version 2. *r*: Pearson’s correlation; *p*: p-value (two-tailed); *n*: sample size; *BF*<sub>10</sub>: Bayes factor.  
 802 \**p*<.05 (uncorrected); \*\**p*<.01 (significant after correcting for multiple correlations (Bonferroni)).

A	SRS-2				AQ				TAS-20				MAIA-2			
	<i>r</i>	<i>p</i>	<i>BF</i> <sub>10</sub>	<i>n</i>	<i>r</i>	<i>p</i>	<i>BF</i> <sub>10</sub>	<i>n</i>	<i>r</i>	<i>p</i>	<i>BF</i> <sub>10</sub>	<i>n</i>	<i>r</i>	<i>p</i>	<i>BF</i> <sub>10</sub>	<i>n</i>
SRS-2	1			34	.877	.000**	2.027e+8	32	.412	.015*	3.554	34	-.590	.000**	135.946	34
AQ					1			36	.587	.000**	184.595	36	-.542	.001**	56.029	36
TAS-20									1			38	-.214	.196	.452	38
MAIA-2													1			38
B	SRS-2				AQ				TAS-20				MAIA-2			
	<i>r</i>	<i>p</i>	<i>BF</i> <sub>10</sub>	<i>n</i>	<i>r</i>	<i>p</i>	<i>BF</i> <sub>10</sub>	<i>n</i>	<i>r</i>	<i>p</i>	<i>BF</i> <sub>10</sub>	<i>n</i>	<i>r</i>	<i>p</i>	<i>BF</i> <sub>10</sub>	<i>n</i>
SRS-2	1			17	.798	.000**	161.605	16	-.176	.500	.370	17	-.579	.015*	4.639	17
AQ					1			18	.009	.971	.292	18	-.626	.005**	1.401	18
TAS-20									1			19	-.024	.923	.285	19
MAIA-2													1			19

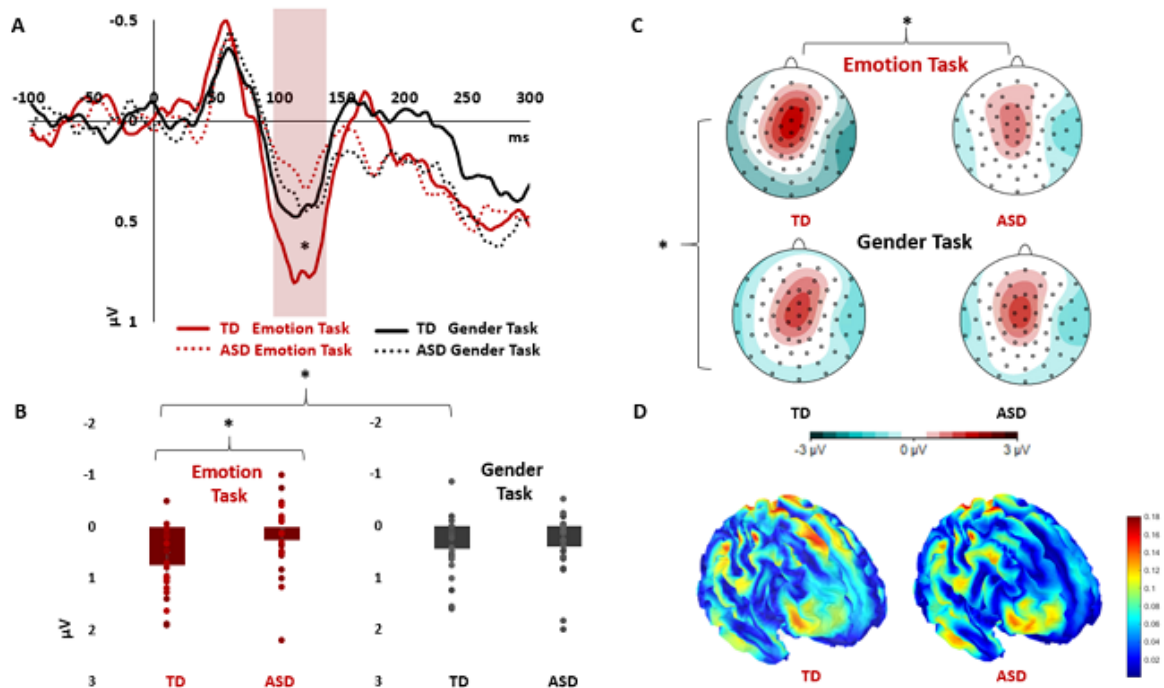
803

804 **Figure 1. Experimental Design.** **A.** Task: faces were presented at 500 ms from fixation cross onset and  
 805 in 50% of trials tactile stimulation was delivered on the left finger after 605 ms (105 ms after face onset,  
 806 following Sel et al., 2014). In 10% of trials, a question appeared after 1100 ms (Emotion Task: «Is s/he  
 807 fearful?» Or «Is s/he happy?»; Gender Task: «Is s/he male?» Or «Is s/he female? »). **B.** Subtraction of  
 808 Visual-Only Condition (VOC), with no tactile stimulation, from Visuo-Tactile Condition (VTC), when  
 809 tactile stimulation was delivered. This method allowed us to isolate pure somatosensory evoked activity  
 810 from visual carry-over effects (SEP (VEP free)). (Created with BioRender.com)



811

812 **Figure 2.** SEP (VEP free) P100 results. **A.** SEP P100 group differences in the frontal region (averaged  
813 activity of 6 electrodes), TD show enhanced positivity for emotion task compared to gender task  
814 ( $p=.044$ ,  $BF_{+0} = 3.044$ ) and to emotion task in ASD ( $p=.047$ ,  $BF_{+0} = 3.049$ ) **B.** Boxplots with individual  
815 data points of the P100 SEP amplitudes in the frontal region, in emotion and gender tasks, for the TD  
816 and ASD groups. **C.** Topographical maps of the P100 electrophysiological activity, revealing increased  
817 positivity in fronto-parietal regions during emotion processing in TD but not ASD. **D.** Source  
818 reconstruction of the P100 SEP (VEP free) component, highlights active voxels in Brodmann Area 6,  
819 Primary and Secondary somatosensory cortices, and prefrontal areas.  
820 VOC: Visual Only Condition; VTC: Visuo-Tactile Condition; SEP: Somatosensory Evoked Potentials;  
821 VEP: Visual Evoked Potentials. (\* $p<.05$ , two-tailed).



822

823

824 **Table 3.** Correlations between autistic traits (A) alexithymia and interoceptive awareness (B) and SEP  
 825 P100 amplitudes in the whole sample of participants.

826 SRS-2: Social Responsiveness Scale; AQ: Autism Quotient; TAS-20: Toronto Alexithymia Scale;  
 827 MAIA-2: Multidimensional Assessment of Interoceptive Awareness. Frontal emotion/gender: averaged  
 828 somatosensory activity from the six electrodes placed in the frontal region; Dorsal emotion/gender:  
 829 averaged somatosensory activity from the six electrodes placed in the dorsal region, close to the midline;  
 830 Overall emotion/gender: averaged somatosensory activity from the eighteen electrodes placed over  
 831 fronto-parietal regions. *r*: Pearson’s correlation; *p*: p-value (two-tailed);  $BF_{0-}$ : Bayes Factor for negative  
 832 correlation;  $BF_{0+}$ : Bayes Factor for positive correlation; *n*: sample size.  
 833 \* $p < .05$  (uncorrected); \*\* $p < .01$  (significant after correcting for multiple correlations (Bonferroni))

A	SRS-2				AQ			
	<i>r</i>	<i>p</i>	$BF_{0-}$	<i>n</i>	<i>r</i>	<i>p</i>	$BF_{0-}$	<i>n</i>
<i>Frontal emotion</i>	-.551	.001**	101.457	34	-.518	.001**	63.442	36
<i>Frontal gender</i>	-.288	.098	1.497	34	-.314	.063	2.121	36
<i>Dorsal emotion</i>	-.470	.005**	18.413	34	-.479	.003**	27.661	36
<i>Dorsal gender</i>	-.183	.299	.604	34	-.241	.157	.996	36
<i>Overall emotion</i>	-.539	.001**	75.863	34	-.528	.001**	79.557	36
<i>Overall gender</i>	-.301	.084	1.713	34	-.361	.030*	3.885	36
B	TAS-20				MAIA-2			
	<i>r</i>	<i>p</i>	$BF_{0-}$	<i>n</i>	<i>r</i>	<i>p</i>	$BF_{0+}$	<i>n</i>
<i>Frontal emotion</i>	-.276	.094	1.482	38	.417	.009**	1.539	38
<i>Frontal gender</i>	-.253	.126	1.164	38	.152	.361	.491	38
<i>Dorsal emotion</i>	-.270	.102	1.387	38	.402	.012*	8.188	38
<i>Dorsal gender</i>	-.241	.146	1.032	38	.095	.571	.335	38
<i>Overall emotion</i>	-.257	.120	1.211	38	.403	.012*	8.288	38
<i>Overall gender</i>	-.327	.045*	2.712	38	.153	.36	.492	38

834

835

836 **Table 4.** Correlations between autistic traits (A) alexithymia and interoceptive awareness (B) and SEP  
 837 P100 amplitudes in the ASD group.

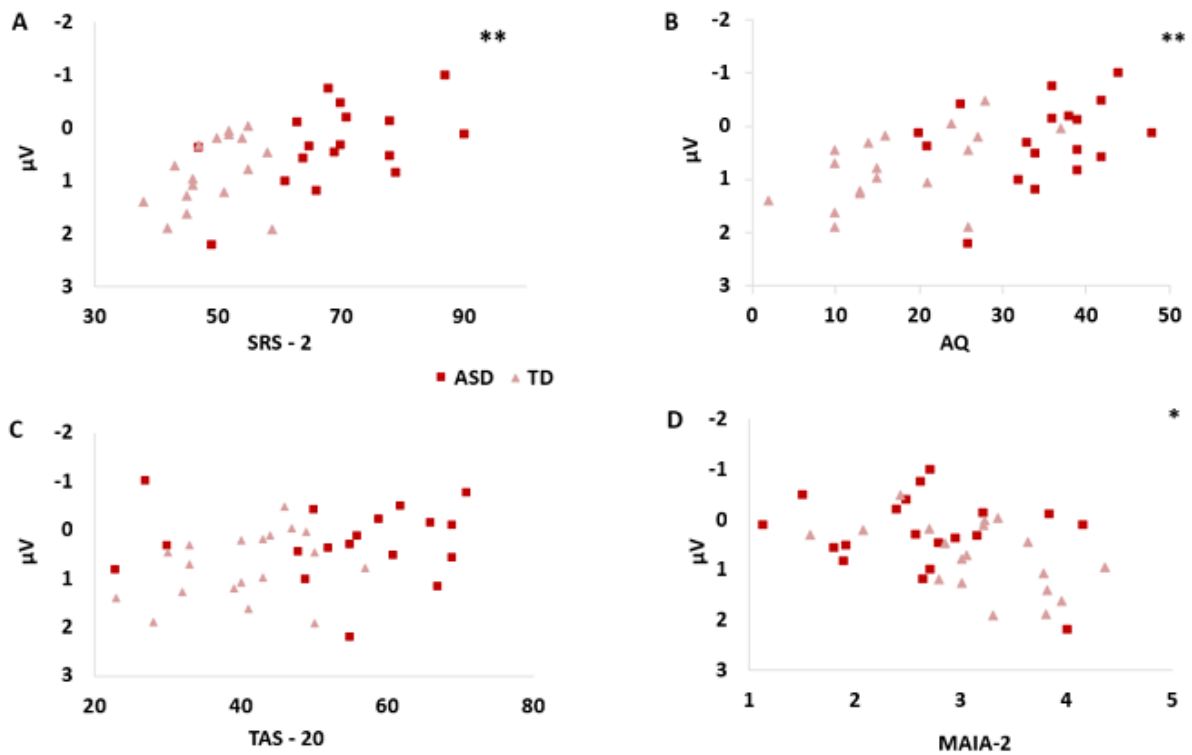
838 SRS-2: Social Responsiveness Scale; AQ: Autism Quotient; TAS-20: Toronto Alexithymia Scale;  
 839 MAIA-2: Multidimensional Assessment of Interoceptive Awareness. Frontal emotion/gender: averaged  
 840 somatosensory activity from the six electrodes placed in the frontal region; Dorsal emotion/gender:  
 841 averaged somatosensory activity from the six electrodes placed in the dorsal region, close to the midline;  
 842 Overall emotion/gender: averaged somatosensory activity from the eighteen electrodes placed over  
 843 fronto-parietal regions. *r*: Pearson’s correlation; *p*: p-value (two-tailed); *BF*<sub>0-</sub>: Bayes Factor for negative  
 844 correlation; *BF*<sub>0+</sub>: Bayes Factor for positive correlation; *n*: sample size.  
 845 \**p*<.05 (uncorrected); \*\**p*<.01 (significant after correcting for multiple correlations (Bonferroni)).

A	SRS-2				AQ			
	<i>r</i>	<i>p</i>	<i>BF</i> <sub>0-</sub>	<i>n</i>	<i>r</i>	<i>p</i>	<i>BF</i> <sub>0-</sub>	<i>n</i>
<i>Frontal emotion</i>	-.517	.034*	4.718	17	-.313	.207	1.082	18
<i>Frontal gender</i>	-.334	.191	1.182	17	-.155	.539	.500	18
<i>Dorsal emotion</i>	-.513	.035*	4.528	17	-.394	.105	1.849	18
<i>Dorsal gender</i>	-.240	.353	.725	17	-.238	.343	.723	18
<i>Overall emotion</i>	-.622	.008**	15.703	17	-.522	.026*	5.659	18
<i>Overall gender</i>	-.320	.211	1.093	17	-.263	.292	.823	18
B	TAS-20				MAIA-2			
	<i>r</i>	<i>p</i>	<i>BF</i> <sub>0-</sub>	<i>n</i>	<i>r</i>	<i>p</i>	<i>BF</i> <sub>0+</sub>	<i>n</i>
<i>Frontal emotion</i>	-.025	.919	.307	19	.214	.38	.649	19
<i>Frontal gender</i>	-.091	.710	.387	19	.113	.644	.420	19
<i>Dorsal emotion</i>	-.206	.397	.626	19	.381	.107	1.786	19
<i>Dorsal gender</i>	-.268	.268	.859	19	.297	.216	1.020	19
<i>Overall emotion</i>	-.121	.622	.433	19	.417	.076	2.354	19
<i>Overall gender</i>	-.241	.32	.745	19	.294	.222	.997	19

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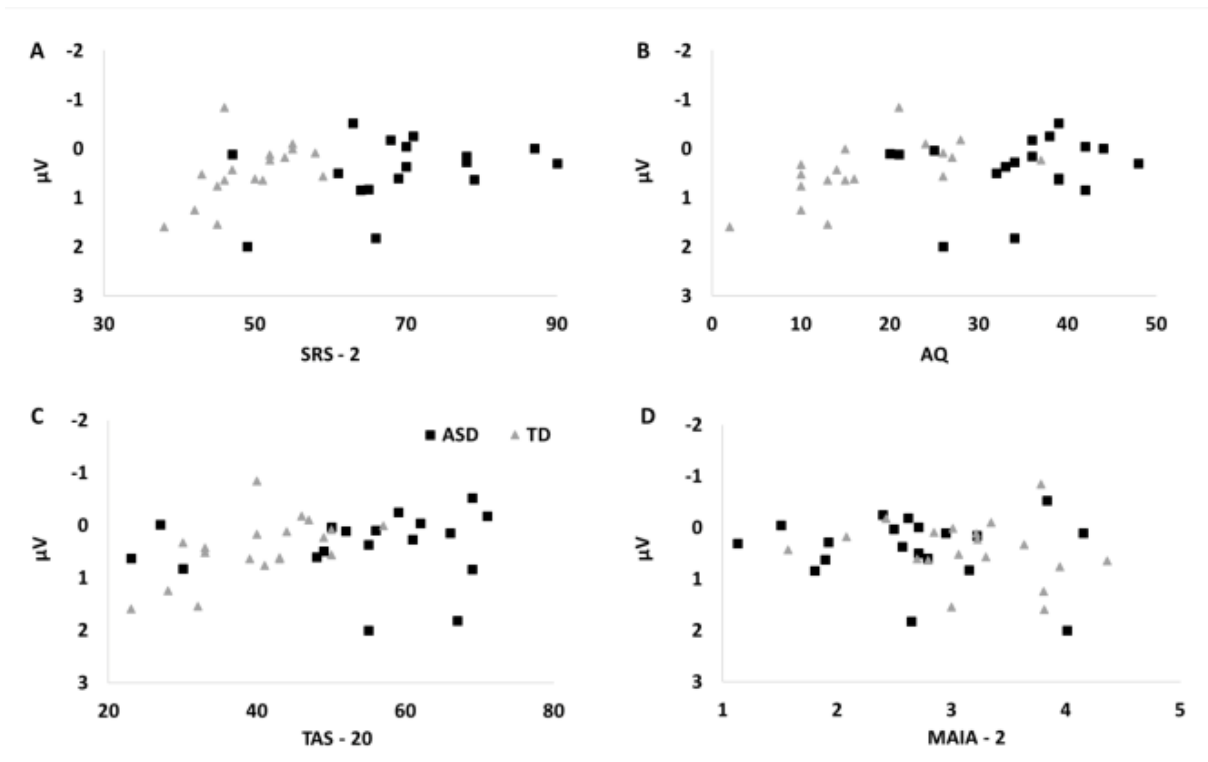
848 **Figure 3.** *Correlations between personality traits and frontal SEP P100 amplitudes in emotion task.*  
849 Autistic traits, but not Alexithymia, are significantly correlated with SEP frontal P100 amplitudes in  
850 emotion task. **A.** Social Responsiveness Scale (SRS):  $**p=.001$ ,  $BF_0 = 101.457$ ; **B.** Autism Quotient  
851 (AQ):  $**p=.001$ ,  $BF_0 = 63.442$ ; **C.** Toronto Alexithymia Scale (TAS-20):  $p=.094$ ,  $BF_0 = 1.482$ . **D.**  
852 Interoceptive awareness measured with the Multidimensional Assessment of Interoceptive Awareness  
853 (MAIA-2) is also correlated with frontal SEP P100 amplitudes ( $*p=.009$ ,  $BF_{+0} = 1.539$ ).



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856 **Figure 4.** *Correlations between personality traits and frontal SEP P100 amplitudes in gender task.*  
857 All correlations between personality traits and frontal SEP P100 in gender task are not significant. **A.**  
858 Social Responsiveness Scale (SRS-2),  $p=.098$ ,  $BF_0 = 1.497$ ; **B.** Autism Quotient (AQ),  $p=.063$ ,  $BF_0 =$   
859  $2.121$ ; **C.** Toronto Alexithymia Scale (TAS-20),  $p=.152$ ,  $BF_0 = 1.164$ . **D.** Multidimensional Assessment  
860 of Interoceptive Awareness (MAIA-2),  $p=.361$ ,  $BF_{+0} = .491$ .

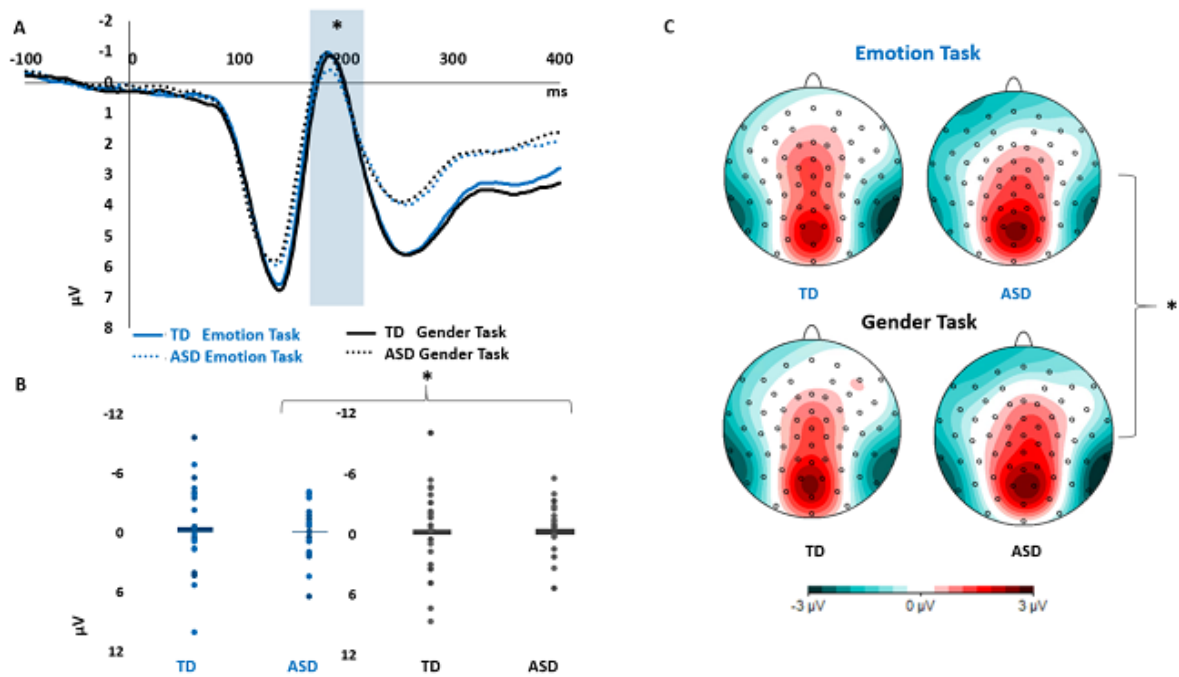


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863 **Figure 5. VEP N170 group differences.**

864 **A.** Reduced amplitude for emotion task compared to gender task in ASD (\* $p=.015$ ,  $BF_{10} = 3.639$ ) but  
865 not in TD ( $p=.541$ ,  $BF_{10} = .282$ ). **B.** Boxplots with individual data points of the N170 VEP amplitudes  
866 in emotion and gender tasks, for the TD and ASD groups. **C.** Topographical maps of the N170  
867 electrophysiological activity, highlighting reduced negativity over occipito-temporal regions during  
868 emotion processing compared to the control task in ASD but not TD.



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