Understanding Emotional Flexibility in Autism: The Social Factor Matters

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Abstract

Autistic individuals often present difficulties in flexibly adjusting their behavior, yet laboratory experiments have yielded inconsistent results, potentially due to various influencing factors requiring precise examination. This study aimed to investigate the hypothesis that the social content of stimuli could play a specific role in some of the flexibility challenges faced by autistic individuals. We analyzed data from 256 adult participants (124 with autism), matched in age, gender, and sex, who performed an emotional shifting task involving unpredictable shifts between positive and negative stimuli. In addition, the task had a social and a non-social condition. Our results revealed a larger switch cost in the social compared to the non-social condition, which was more pronounced in autism compared to non-autistic individuals. Expanding upon previous research demonstrating a greater switch cost in autistic than non-autistic individuals for socio-emotional stimuli, our study further extends these findings by highlighting that the social context, rather than the emotional nature of the stimuli alone, could play a particular role in some of the flexibility challenges faced by autistic individuals. Nevertheless, further studies are needed to investigate if these results also apply to autistic children or autistic individuals who also have intellectual disabilities.

Background

Some characteristics associated with autism, such as stereotyped behaviors and resistance to changes, have been linked to difficulties in flexibility (Mostert-Kerckhoffs et al., 2015). Cognitive flexibility, the capacity to adjust one's behavior in response to changes (for a broader conceptualization, see Ionescu, 2012), is often challenging for autistic individuals (for a review, see, Leung & Zakzanis, 2014). Cognitive flexibility difficulties can also impair social interaction, as they require a flexible adjustment. Conversely, higher cognitive flexibility has been linked to greater social competences in interacting with others (Ciairano et al., 2006). While real-life assessments of flexibility using explicit questionnaires such as the Behavioral Rating Inventory of Executive Function (Gioia et al., 2000; Roth et al., 2005) highlight cognitive flexibility challenges in autism (Granader et al., 2014; Wallace et al., 2016), studies employing cognitive flexibility tasks have yielded inconsistent findings (for reviews, see Geurts et al., 2009; Leung & Zakzanis, 2014), possibly due to task heterogeneity (de Vries & Geurts, 2012; Van Eylen et al., 2015). Tasks involving unpredictable shifts, implicit rules, or social content may be more ecologically valid and could be more appropriate to underline the difficulties encountered by autistic individuals (Landry & Al-Taie, 2016; Latinus et al., 2019; Van Eylen et al., 2011), who may nevertheless adapt to predictable and explicit shifts (Geurts et al., 2009).

Hence, Lacroix et al. (2022) compared the performance of autistic and non-autistic (NA) participants on two types of flexibility tasks. The Emotional Flexibility task (EST - Biro et al., 2021) involved unpredictable shifts with implicit rules and socio-emotional content. Participants were tasked with evaluating the valence of an emotional face first without its context and then with its context, where the context could either confirm or contradict the initial evaluation. In the latter case, participants had to adjust their initial prediction based on the context. On the other hand, the Task Switching Task (TST - Rogers & Monsell,
1995) featured predictable shifts with explicit rules and non-social/non-emotional content. Consistent with their hypotheses, the study revealed a larger switch cost in autism compared to NA participants in the EST, which was not observed in the TST. While these findings suggest that flexibility difficulties in autism may be particularly pronounced in complex situations involving unpredictable and implicit shifts of socio-emotional stimuli, they do not elucidate which specific factor (unpredictability, implicitness, social content, or emotional content) contributes most to the flexibility challenges of autistic individuals. Further investigation is warranted to address this question.

Furthermore, their findings revealed sex differences, particularly evident on the EST. Autistic females exhibited an intermediate profile of emotion recognition in context, positioned between that of autistic males and NA females, and significantly differing from both groups. This outcome aligns with a growing body of literature highlighting sex and gender differences in the phenotypes of autistic males and females, indicating better social abilities for autistic females than males (for a comprehensive review and meta-analysis, refer to Wood-Downie et al., 2021). While these results may be supported by neurophysiological sex differences in face processing in autism (Lacroix et al., 2024), the evidence remains limited and requires replication.

Thus, the present study seeks to replicate and extend the findings of Lacroix et al. (2022). Indeed, Lacroix et al. (2022) demonstrated increased difficulty among autistic individuals, compared to non-autistic, in adjusting their predictions to the context of socio-emotional stimuli on the Emotional Flexibility task (EST), but it remains unclear if this effect is specific to social stimuli or extends to all emotional stimuli. Therefore, we developed a new task (referred to as EST-2) that includes both social and non-social emotional stimuli to explore the impact of the social dimension on flexibility in autistic and non-autistic individuals. Our hypothesis posits that autistic individuals will exhibit greater difficulty in shifting their perspectives (adjusting their predictions) compared to NA individuals, particularly in response to social stimuli, compared to non-social stimuli. Additionally, we anticipate that autistic females will demonstrate fewer difficulties in this regard than autistic males. Finally, we expect that negative stimuli will be more challenging to process than positive stimuli (Leppänen et al., 2003), especially for autistic participants and in the social condition (Yang et al., 2022). A more detailed version of the hypotheses is provided in the pre-registration document.

**Method**

**Participants**

A total of 274 participants, aged between 18 and 45 years old, completed the entire study. Including participants aged 18 to 45 in the study accounts for the late maturation and early decline of executive function. In accordance with our exclusion criteria outlined in the preregistration document, 5 non-autistic participants were excluded due to an autism quotient exceeding 32. Additionally, 7 autistic participants and 1 non-autistic participant were excluded due to accuracy on emotion recognition without context falling below 60%. Considering the investigation of sex and gender differences, the
Autistic transgender individuals (female-to-male) were also excluded from the analyses as they were not enough to perform group comparisons. Thus, participants are matched in sex and gender but are all cisgender. The final sample comprised 124 autistic participants (63 females) and 132 non-autistic participants (70 females). Autistic participants were recruited with the assistance of specialized centers, physicians, autism-focused associations, and social networks. In the latter case, participants were required to contact us to receive the study link, allowing us to verify their formal diagnosis. Non-autistic participants were recruited through social networks. They should not suspect themselves to be autistic or have a close family member (child, parent, brother) on the autism spectrum. All participants should not be undergoing medical treatment that could alter their cognitive function. All procedures performed in this study involving human participants were conducted in accordance with the Code of Ethics of the World Medical association (Declaration of Helsinki) and the study received a positive approbation by the local ethics committe (CER-Grenoble Alpes, COMUE University Grenoble Alpes, IRB00010290).

Material and procedure

The study was conducted online using the PsyToolkit platform (Stoet, 2010, 2016). At the beginning of the study, participants were presented with an informed consent form, which they had to approve before proceeding. They were also instructed to ensure they were in a quiet and undisturbed environment during the tasks. They were prompted to provide demographic information including sex, age, and diagnoses (i.e, autism diagnosis, and other psychiatric/neurological diagnoses or other neurodevelopmental diagnoses). Following this, participants engaged in two tasks: the EST-2 and another task for a separate research question, presented in a randomized order. Subsequently, participants were asked to complete the Autism Spectrum Questionnaire. Finally, to assess the validity of the experimental condition, participants were queried about any disturbances during the tasks and invited to provide any comments.

The Emotional Shifting Task − 2 (EST − 2)

This task, lasting 10 minutes, was composed of 72 pairs of emotional stimuli, half of them were social (i.e., involving humans), and the other half were not social (i.e., not involving humans). In addition, in each condition, half of the stimuli had a positive valence and the other half had a negative valence. The stimuli used have been selected from the following databases: Natural Disasters Picture System (Merlihot et al., 2018), International Affective Picture System (Lang et al., 1997), Geneva Affective Picture Database (Dan-Glauser & Scherer, 2011), Nencki Affective Picture System (Marchewka et al., 2014), and Open Affective Standardized Image Set (Kurdi et al., 2017), but also from internet (copyright free images). The selection was performed after a series of pretests regarding their valence and arousal, described in Supplementary Materials. There was no significant difference in arousal between social and non-social stimuli.

During the EST-2, each trial was composed of a cropped image appearing first. For the social stimuli, the image was cropped around a human body part (usually, the face), and for non-social stimuli, around a meaningful part of the image (See Fig. 1. A). Participants were asked to evaluate the valence of these
cropped stimuli as negative or positive. Then, the image appeared uncropped and the participants were asked to evaluate the valence of the uncropped image. In half of the trials of each condition (i.e., social and non-social), the valence of the cropped and uncropped images were congruent, corresponding to the non-shift condition. In the other half, they were incongruent corresponding to the shift condition. Hence the plan included 9 stimuli pairs x 2 social conditions x 2 emotions x 2 shift conditions. The Fig. 1. B represents the schematic of one trial. All stimuli pairs were randomized.

The Autism Spectrum Quotient (AQ - Baron-Cohen et al., 2001) The AQ is a 50-item scales in which the participants rated their agreement with statements on a 4-point Likert scale. A score of 32 and above is associated with high autistic traits.

Analyses

All analyses were conducted using R (R Core Team, 2020) and RStudio (RStudio Team, 2019) version 2023.12.1 + 402. We compared the four subgroups of our sample (autistic males, autistic females, non-autistic (NA) males, and NA females using Pearson's Chi-square test with Yale's correction for categorical variables and linear models for continuous variables. For post-hoc comparisons of significant differences in categorical and continuous variables, we employed Chi-square test of association and Tukey's HSD, respectively.

Analyses on the EST-2 were conducted on accuracy (correct responses - CR) and response time (RT) for correct responses on the uncropped image, given that participants had provided a correct answer on the cropped image, utilizing the lme4 package (Bates et al., 2015). Accuracy analysis on the cropped images is presented in Supplementary Materials. A mixed-effects logistic regression was employed for CR analysis, while a generalized mixed-effects model with an inverse Gaussian function was used for RT analyses (tables with results are presented in Supplementary Materials). The models included group (autism vs. NA), sex (males vs. females), shift condition (non-shift vs. shift), social condition (non-social vs. social), and emotion (negative vs. positive) as fixed effects, along with psychiatric/neurological and neurodevelopmental diagnoses other than autism as covariates, as some of them can impair executive functions (e.g., ADHD).

The random effects structure was kept maximal and reduced in case of model non-convergence (Barr et al., 2013). Due to the absence of a standardized approach for computing effect sizes in mixed models, unstandardized effect sizes are presented (Rights & Sterba, 2019). They correspond to β coefficient values, as each factor within the model involved dichotomous variables contrast-coded with −0.5 and 0.5, thus allowing straightforward interpretation. Significant interactions are plotted and described using estimated marginal means (i.e., the estimation of each effect devoid of the influence of other factors accounted for in the statistical model) and 95% confidence intervals (Cumming, 2009; Garofalo et al., 2022), employing the emmeans package (Lenth, 2021). Pairwise comparisons using estimated marginal means and error were also conducted, employing Tukey adjustment to estimate differences (β values). As pre-registered, correlations with AQ were performed as complementary analyses. They are presented in Supplementary Materials.
Results

Participants
Table 1
Demographics. Mean value, standard deviation (SD), and range for age, education, AQ scores, age at the diagnostic of autism, as well as the percentage of participants with a diagnosis other than autism for each group, and group comparison. AQ = Autism Quotient, N-miss = number of missing data.

<table>
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<th></th>
<th>Autistic Females (N = 63)</th>
<th>Autistic Males (N = 61)</th>
<th>Non Autistic Females (N = 70)</th>
<th>Non Autistic Males (N = 62)</th>
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<td>70 (100.0%)</td>
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<td>14 (23.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
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<td>66 (94.3%)</td>
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<td>18 (29.5%)</td>
<td>4 (5.7%)</td>
<td>3 (4.8%)</td>
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</table>
Demographics of the final sample are summarized in Table 1. There were no significant differences in age between groups. However, disparities emerged in educational attainment, with autistic males exhibiting lower levels compared to both NA males ($p < .001$) and females ($p = .03$). As anticipated, significant differences were found in AQ scores, with autistic individuals scoring higher than NA counterparts (all $p < .001$). Furthermore, NA males demonstrated higher AQ scores than NA females ($p = .03$). Autistic males received their diagnosis at a younger age compared to autistic females ($p < .001$). Lastly, autistic participants presented with a greater number of comorbid diagnoses than NA participants (all $p < .001$).

**EST-2**

Analysis of valence accuracy on the picture with context, following a correct answer on the picture without context, revealed fewer correct responses (CR) and longer response times (RT) in the shift compared to the non shift condition (CR : $\beta = -2.9$, 95% CI [-3.45, -2.34], $p < 0.001$; RT : $\beta = 158$, 95% CI [137, 178], $p < 0.001$), and in the social compared to the non-social condition (CR : $\beta = -0.66$, 95% CI [-1.2, -0.13], $p = 0.016$; RT : $\beta = 61$, 95% CI [12, 111], $p = 0.016$). Autistic participants were less accurate ($\beta = 0.3$, 95% CI [0.06, 0.54], $p = 0.013$) and slower ($\beta = -90$, 95% CI [-110, -69], $p < 0.001$) than non-autistic participants. Additionally, RT were longer for negative than positive stimuli ($\beta = -66$, 95% CI [-85, -47], $p < 0.001$) and for females than males ($\beta = 19$, 95% CI [2, 37], $p = 0.031$).

The main effects on RT were qualified by significant two-way and three-way interaction effects, which are presented on Fig. 2 and in the following. First, the interaction effect between group and shift ($\beta = -27$, 95% CI [-43, -10], $p = 0.001$) revealed that the difference between shift and non shift condition was larger in autism ($\beta = -171$, 95% CI [-199, -144]) than in NA individuals ($\beta = -144$, 95% CI [-174, -114]). Then, the interaction effect between the group and the social nature of the stimuli ($\beta = -55$, 95% CI [-74, -36], $p < 0.001$) indicated that the difference in RT between social and non-social stimuli was also larger in autism ($\beta = -89$, 95% CI [-153, -24]) than in NA ($\beta = -34$, 95% CI [-102, 34]). Finally, the interaction between the shift and the social nature of the stimuli ($\beta = 103$, 95% CI [85, 121], $p < 0.001$) revealed that the RT difference between social and non-social stimuli was larger in the shift ($\beta = -113$, 95% CI [-181, -44]) than in the non-shift condition ($\beta = -10$, 95% CI [-73, 54]). However, these three interactions were qualified by a three-way interaction between the group, the shift and the social nature of the stimuli ($\beta = -42$, 95% CI [-59, -25], $p < 0.001$) indicating that the larger difference between the shift and the non shift condition in autism compared to NA was more pronounced in the social condition compared to the non-social condition (shift vs. no shift in ASD and non-social: $\beta = -109$, 95% CI [-147, -72]; ASD and social: $\beta = -233$, 95% CI [-267, -199]; NA and non-social: $\beta = -103$, 95% CI [-145, -62]; NA and social: $\beta = -185$, 95% CI [-221, -150])

In addition, a significant interaction between group and emotion ($\beta = -28$, 95% CI [-50, -6], 95% CI [-50, -6], $p = 0.012$) showed that the difference in RT between negative and positive stimuli was more pronounced in NA participants ($\beta = 80$, 95% CI [50, 110]) than in autistic individuals ($\beta = 52$, 95% CI [25, 79]). This interaction was qualified by a three-way interaction between group, sex and emotion ($\beta = 24$, 95% CI [0,
49], \( p \, 0.05 \), indicating that this slower response time for negative than positive stimuli in NA was more pronounced in males (positive vs. negative stimuli in NA males: \( \beta = 95, 95\% \text{ CI} [58, 133] \), autistic males: \( \beta = 55, 95\% \text{ CI} [18, 93] \), NA females: \( \beta = 65, 95\% \text{ CI} [22, 108] \), autistic females: \( \beta = 49, 95\% \text{ CI} [14, 84] \) ).

Finally, there was an interaction between shift and sex (\( \beta = 34, 95\% \text{ CI} [13, 55], \ p = 0.002 \)), indicating that the difference in RT between the shift and the non-shift condition was smaller in males (\( \beta = -141, 95\% \text{ CI} [-171, -111] \)) than females (\( \beta = -175, 95\% \text{ CI} [-204, -145] \)). However, this interaction, along with the aforementioned interaction between group and shift, was further qualified by a three-way interaction involving group, shift, and sex (\( \beta = 56, 95\% \text{ CI} [39, 73], \ p < 0.001 \)). This revealed that the diminished difference in RT between the shift and non-shift conditions in males compared to females was more pronounced in the non-autistic group than in the autistic group (shift vs. no shift in ASD Females: \( \beta = -174, 95\% \text{ CI} [-212, -136] \); ASD Males: \( \beta = -168, 95\% \text{ CI} [-206, -131] \); NA females: \( \beta = -175, 95\% \text{ CI} [-213, -137] \); NA males: \( \beta = -113, 95\% \text{ CI} [-153, -74] \)).

Meanwhile, we also observed an interaction effect between group, sex and the social nature of the stimuli on CR (\( \beta = -0.06, 95\% \text{ CI} [-1, 1], \ p = 0.852 \)). This indicates a greater discrepancy in CR between social and non-social stimuli in autism compared to NA, which was more pronounced in females (social vs. not social in autistic females: \( \beta = 1.09, 95\% \text{ CI} [0, 2] \); autistic males: \( \beta = 0.56, 95\% \text{ CI} [0, 1] \); NA females: \( \beta = 0.46, 95\% \text{ CI} [0, 1] \); NA Males: \( \beta = 0.54, 95\% \text{ CI} [0, 1] \)). This interaction is represented in Fig. 3.

**Discussion**

Following the inconsistencies found in studies on flexibility in autism, the present study pursued several objectives. Firstly, it sought to replicate and extend the findings of Lacroix et al. (2022), which demonstrated that autistic adults encountered greater difficulties in flexibly adjusting their predictions to unpredicted socio-emotional contexts compared to NA individuals, using a distinct set of participants and stimuli. More importantly, the study also set out to explore whether the social nature of stimuli played a significant role in the impaired performances of autistic individuals. Finally, the study aimed to investigate sex differences. Our results corroborate the findings of Lacroix et al. (2022), indicating that autistic individuals face greater challenges in adjusting their predictions to emotional contexts compared to NA individuals. In line with our hypothesis, we also observed that this difficulty was particularly pronounced when the emotional context was social. However, contrary to our initial predictions, the sex differences found in the present study diverged from those of the preceding research.

In the current study, participants were tasked with evaluating the emotional valence of a cropped image initially and then reassessing the same image within its context. Our analyses revealed heightened difficulties in accurately and promptly re-evaluating the emotional valence within context when the valence differed from the initial evaluation (i.e., the prediction). In other words, there was a switch cost associated with this re-evaluation, indicating the efficacy of the task. Notably, we also identified a
significant interaction between the shift and group, suggesting that this switch cost was more pronounced in autistic individuals (compared to NA), who struggled to adjust to unpredicted socio-emotional contexts. These results replicate prior findings on NA (Biro et al., 2021; Biró et al., 2022) and autistic participants (Lacroix et al., 2022) using a similar task but with novel stimuli and participants, underscoring the robustness of both the tasks (i.e., EST and EST-2) and the obtained results.

As stated above, the main objective of the current study was to go beyond replication and to investigate the impact of the social nature of the stimuli on the results. Our findings showed that the social nature of emotional stimuli significantly decreases CR and increases RT. This result is in line with slower RT for social compared to non-social affective scenes (balanced in arousal) found on the COMPASS database (Weierich et al., 2019). However, this finding is extended by the interaction effect, showing that the social nature of emotional stimuli increases the switch cost CR and RT compared to non-social stimuli (despite no significant difference in arousal between social and non-social stimuli). With the advantage of using naturalistic stimuli, this novel result adds evidence to the inherently ambiguous nature of human affective states (Hassin et al., 2013) (compared to non-social affect stimuli), particularly in situations where the context does not correspond to the emotion that can be predicted from a human character. It can also suggest a greater attentional capture by social information and greater disengagement, that could lead to slower RT (Weierich et al., 2019).

Consistent with our preregistered hypotheses, the results revealed a more prolonged for social stimuli than for non-social stimuli, in autistic individuals compared to NA individuals. While there is little research investigating the behavioral response to non-social emotion recognition in autism, this result seems in line with the few studies existing, showing normative behavior or physiological responses (i.e., skin conductance) in autism to non-social emotionally arousing stimuli (Nuske et al., 2013; South et al., 2008). Importantly, this interaction was further qualified by the expected three-way interaction between group, shift, and the social nature of stimuli, highlighting the heightened switch cost for social stimuli in autism compared to NA. These findings align with the range of difficulties that autistic individuals experience during social processing, such as reduced attention to faces and eyes, delayed N170 response to faces, reduced brain activation during face processing, and difficulties in emotion recognition (for meta-analyses see Costa et al., 2021; Frazier et al., 2017; Kang et al., 2018; Lozier et al., 2014). It also corroborates the everyday difficulties experienced by autistic individuals in adjusting to social contexts, often characterized by unpredictability. The results echo previous conclusions suggesting that autistic adults may rely on learned patterns for social evaluation, that would decrease their adjustment to social situations (Palumbo et al., 2015). Interestingly, the non-social condition demonstrated a similar switch cost in autism and NA, suggesting that autistic individuals can recognize and adapt to unpredictable emotional changes in non-social scenes, but are confused with social cues probably because of their higher level of ambiguity (Fujino et al., 2019; Latinus et al., 2019).

While emotion recognition is usually faster in females than males including within autism research (Lacroix et al., 2022; Sucksmith et al., 2013; but Baron-Cohen et al., 2015), this effect was not replicated in our study, where males responded faster than females. We also observed two-way and three-way
interactions indicating a reduced difference in RT between the shift and non-shift conditions in males, particularly evident in NA individuals. Furthermore, the results showed that the difference in accuracy between social and non-social stimuli was increased in autism, particularly in females. While this result might indicate that social situations would be particularly confusing for autistic females compared to NA females, inconsistencies between current and previous results warrant caution in drawing conclusions about sex and gender differences.

Finally, our analyses revealed longer RT when the emotional context was negative, especially among NA individuals (contrary to our preregistered complementary hypothesis that this effect would be more pronounced in autism) and particularly in males. However, no interaction with the shift condition was observed, contrary to previous findings (Biro et al., 2021; Lacroix et al., 2022). Nevertheless, this result aligns with existing literature indicating shorter reaction times for positive stimuli in both NA (Leppänen et al., 2003) and autistic individuals (for a review, see Harms et al., 2010).

**Limitations**

The online nature of the study presents a limitation, as it reduces control over diagnosis and experimental conditions. However, the participants were carefully selected (see Method). In addition, online research remains an appropriate method for studying autistic individuals, at least those with no intellectual disability, as it mitigates anxiety related to unfamiliar situations and social interactions (Gillespie-Lynch et al., 2014).

Certain socio-demographic differences may also be perceived as weaknesses. Specifically, autistic males exhibited lower educational attainment compared to other groups. However, educational achievement in autism often falls below what is expected based on IQ (Estes et al., 2011), and the mean educational attainment of autistic males remains high, corresponding to the second year of a bachelor degree program. Thus, although our sample appears to be homogeneous in terms of intellectual abilities, it also exhibits the limitation of not being fully representative of the autism spectrum, similar to other studies involving autistic individuals. Autistic and NA individuals also differed in the number of comorbidities, consistent with existing literature (Lugo-Marín et al., 2019), and this was accounted for in our analyses.

**Conclusions**

In summary, our study demonstrates that autistic individuals exhibit a larger switch cost than NA individuals when evaluating the emotional content of an image within an unpredictable context, replicating previous findings. However, our study adds new important insight by revealing that this discrepancy is only evident for social stimuli, while autistic individuals show no difference in switch cost compared to NA individuals in non-social conditions. These results suggest that autistic individuals do not inherently struggle to flexibly adjust their predictions but that this difficulty is modulated by the nature of the stimuli. Finally, the findings also showed that the social nature of the stimuli impaired
flexibility also in NA individuals, suggesting that social affective stimuli might be more ambiguous or might induce more difficulties to disengage than non-social affective stimuli. Some future directions would involve testing whether this effect is also present, heightened or diminished, in other neuropsychiatric, neurodevelopmental, or neurodegenerative disorders that also entail affective implications.

Declarations

Author contributions


Acknowledgments

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Availability of data and materials

This study was preregistered on https://osf.io/q963z. All data and materials have been made publicly available on the following osf repository: https://osf.io/7n8gm/?view_only=395f108fb0c74d8f96a0f86179f73ef5.

Declaration of conflicting interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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References


A. Examples of stimuli in each condition for the non-social condition

<table>
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<th>Shift</th>
<th>Non Social</th>
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<td>Positive to Negative</td>
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<tr>
<td>Negative to Positive</td>
<td><img src="image2" alt="Negative to Positive" /></td>
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<tr>
<td>No shift</td>
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<td>Negative to Negative</td>
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</table>

B. Schematic of one trial

**Figure 1**

A. Stimuli. Examples of pairs of stimuli in each condition for the non-social condition for the Emotional Shifting Task, i.e., shift vs. nonshift x positive vs. negative (for the second image). B. Procedure. Schematic of one trial.
Figure 2

Significant interactions on RT. The box plots represent the observed median response time (RT) for the emotion recognition with context, with the interquartile range and individual data points for each condition, and the red crosses represent the observed means. In addition, the colored points represent the estimated marginal means with their 95% CI. The first line (A) represents the significant two-way interactions and the second line represents the significant three-way interactions (in respect to the corresponding two-way interactions). M = Males; F = females; Neg = Negative stimuli (with context); Pos = Positive stimuli (with context); Soc = social stimuli, NonSoc = Non-social stimuli.
Figure 3

Interaction between group, sex, and the social content on correct responses. The box plots represent the observed median correct response rates (CR) for the emotion recognition with context, with the interquartile range and individual data points for each condition, and the red crosses represent the observed means. In addition, the colored points represent the estimated marginal means with their 95% CI.

Supplementary Files

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