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Emotional intelligence and attentional bias to emotional faces: Evidence of hypersensitivity towards emotion information☆

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ABSTRACT

It has been proposed that emotional intelligence (EI) functions as a magnifier of emotional experience. This phenomenon, called the "hypersensitivity hypothesis," predicts that high EI amplifies the emotional aspects of experience (Fiori & Ortony, 2021). We tested whether high EI individuals show stronger attention to emotional than neutral expressions with a dot-probe task in which participants ($N = 155$) had to report a letter appearing behind an emotional or a neutral face. A significant interaction EI by experimental condition showed an attentional bias towards emotional faces associated with high EI: individuals high on emotion understanding were faster to respond to cues replacing an emotional as compared to a neutral face, an effect that was not found for low-EI individuals. Results support that high EI individuals are particularly reactive to emotion information, confirming the basic assumptions of the hypersensitivity hypothesis. Implications for research on EI are discussed.

1. Introduction

Emotional Intelligence (EI), a construct introduced in the psychological literature thirty years ago, encompasses abilities and self-perceptions related to the recognition, expression, understanding, and management of emotions (Petrides & Furnham, 2001; Salovey & Mayer, 1990). Two approaches have been developed to study EI: the trait approach conceives EI as a set of traits and competencies that are part of personality and typically measures it with self-report questionnaires; the ability approach conceptualizes EI as a form of intelligence and typically assesses it with performance tests (Petrides & Furnham, 2001). The mainstream model of ability EI was introduced by Mayer and Salovey (1997) who described it as a set of abilities concerning the recognition of emotions in oneself and others (emotion recognition), the understanding of how emotions originate, develop, and change during emotional experience (emotion understanding), the use of this understanding to enhance thinking and behavior (emotion facilitation) and to better manage one's and others' emotions (emotion management). More recently, evidence supporting a 3-branch model of EI has been provided (Joseph & Newman, 2010; MacCann et al., 2014) as the emotion facilitation branch did not emerge as a separate factor (Fiori & Antonakis, 2011; Palmer et al., 2005; Roberts et al., 2001).

The vast majority of research in the domain of EI has concentrated on clarifying some of the critical issues the construct was confronted with, such as its incremental validity (Joseph & Newman, 2010; Newman et al., 2010), its relationship with intelligence and personality (Andrei et al., 2016; MacCann et al., 2014), and how to measure it, either as an ability (Schlegel & Mortillaro, 2019) or as a personality trait (Petrides & Furnham, 2001).

Probably because of the urgency of addressing these fundamental issues related to the validity and measurement of the EI construct, less research has been developed to understanding the psychological processes underlying individual differences in EI (e.g., Fiori, 2009). As a matter of fact, EI is associated with (mostly) positive outcomes in various domains (e.g., MacCann et al., 2020; Martins et al., 2010). Still, we only have a poor understanding of the emotional and cognitive processes that may account for such outcomes and how they operate in high as compared to low EI individuals (Fiori, 2009).

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1.1. EI and emotion-information processing

A recent contribution addresses this gap in the literature by introducing emotion-information processing as a new component of EI (Fiori et al., 2022). The basic idea is that EI can be conceptualized as having two interrelated but distinct components: 1) EI_K or emotion Knowledge component, which is captured by current ability EI tests and represents mostly acquired and culture-bound knowledge about emotions; 2) EI_P or emotion information Processing component, measured with emotion information processing tasks, which represents how individuals process emotions and, more generally, emotion information. EI_P requires faster processing than EI_K and is based on bottom-up attention-related responses to emotion information. Although the two EI components load into the same underlying latent EI factor, each of them is expected to predict different portions of variability in emotionally intelligent performance: more automatic (system 1) emotional behavior for EI_P and more controlled (system 2) emotional behavior for EI_K (Fiori et al., 2022; Fiori & Vesely-Maillefer, 2018).

1.2. EI and emotional hypersensitivity

This new conceptualization of EI implies that individuals who are high in EI_P, should be positioned on the highest extreme of the EI continuum and be characterized by a stronger sensitivity to emotion and emotion information as measured by more extreme scores on emotional tasks. This possibility, called the 'hypersensitivity hypothesis' (Fiori & Ortony, 2021) poses that high-EI individuals, as compared to low, may experience more intense emotions; have a lower threshold of perception of emotion information; possess a fine-grained discrimination of emotional stimuli and categorize complex emotional stimuli more easily; pay more attention to emotions and emotion information. The current study tested the hypersensitivity hypothesis for the latter indicator of hypersensitivity, namely attention to emotion information.

It should be noted that the definition of hypersensitivity employed in the current research is somewhat similar to that of Sensory Processing Sensitivity (Aron & Aron, 1997), which refers to the tendency to process stimuli more in-depth. However, the current conceptualization of hypersensitivity pertains only to *emotional* stimulation—not to physical or environmental stimulation—and employs experimental tasks rather than self-report questionnaires to assess it.

1.3. The current research

In this study, we employed the dot-probe (DP) paradigm to operationalize EI_P and focused on the idea that hypersensitivity produces an attentional bias towards emotional stimuli. We also explored how the EI_K component or the different ability EI facets are related to this form of hypersensitivity.[2] Participants had to identify and report a target letter that appeared behind one of two faces. One of the two faces displayed an emotion (happiness or anger) and the other was always neutral. If high-EI individuals are characterized by hypersensitivity towards emotional information, this should be reflected in their attention being more "caught" by emotional stimuli (than neutral stimuli), as operationalized by faster response times when judging the target letter replacing an emotional as compared to a neutral face. In other words, we expected the difference in reaction times between the neutral and emotional conditions to increase with EI (Hypothesis 1).

In the current research, we conceptualize hypersensitivity as more extreme (e.g., stronger) attentional bias towards emotion information. (Hyper)sensitivity to emotions can also be evaluated with self-report measures aiming at explaining individual differences in response to emotional stimuli, such as the Affect Intensity Measure (AIM, Larsen, 1984). For this reason, we included the AIM in our study to compare how individuals report their level of perceived emotional sensitivity with how they actually allocate their attention to emotion information. Previous research has shown that affect intensity is related to attention to emotion (e.g., Huang et al., 2013; Thompson et al., 2009). It must be noted though that in these studies, attention to emotion was assessed through self-report measures while it is assessed with an experimental task in the current study. If self-reported sensitivity to emotion is associated with increased attention to emotion information, we would expect to find a larger difference between reaction times in the emotional and neutral conditions for people high on the affect intensity measure compared to people low on this measure (Hypothesis 2). Finally, we also included a measure of fluid intelligence to partial out the effect of fluid intelligence when testing EI and to control for the influence of this type of intelligence on reaction times in our task. The design of the study and the hypotheses were pre-registered and are accessible on OSF (https://osf.io/gnrm5/?view_only=764c5d945a5d4830bc33ce56200bf482).

2. Method

2.1. Participants and procedure

The sample included 239 English-speaking participants recruited on the online platform Prolific (95 % approval rate). Participants took part in a first session in which they completed a battery of questionnaires. One week later, they were asked about their mood at testing time, and performed the dot-probe task. As the entire procedure lasted about an hour and a half and was completed online, a strict exclusion procedure was performed to ensure that participants were fully attentive during the task. There were three attentional checks in total, one in the first and two in the second session. We also considered the number of correct responses to the intelligence test and the emotion recognition test and discarded participants falling 3 sd under the mean (e.g., number of correct responses lower than 4 for both tasks). The final sample (after joining the participants retained in sessions 1 and 2) consisted of 157 participants (33.1 % male, 65.6 % female and 1.3 % other). The participants were aged between 18 and 63 ($M = 29.2$, $SD = 10.0$). All participants were informed about the study and gave their consent to participate following procedures and protocols approved by the ethical committee of the University of Geneva. They were remunerated 7.5 pounds per hour for their participation.

2.2. Measures

2.2.1. The Situational Test of Emotional Understanding-Brief (STEU-B) (Allen et al., 2014)

The STEU-B is a 19-item performance-based test that measures respondents' understanding of emotions felt by protagonists described in a short scenario. Items typically ask the respondent which of five emotions best matches a short-written scenario. Examples of items include: "Xavier completes a difficult task on time and under budget. Xavier is most likely to feel?" (Pride). Responses are scored as correct (1) and or incorrect (0). The test-retest reliability of the full version of the test is 0.72 (Libbrecht & Lievens, 2012).

2.2.2. The Situational Test of Emotional Management-Brief (STEM-B) (Allen et al., 2015)

The STEM-B is an 18-item performance-based test that measures respondents' knowledge of the strategy to adopt to manage emotions in various situations. Respondents are asked to choose the most effective course of action to manage both the emotions the protagonists are feeling and the problems they face in the described situations. Responses are scored according to a weight derived from expert ratings. For

[2] For exploratory purposes, we also employed a measure of trait EI. Because none of the effects associated with trait EI was significant, we do not report results in the current manuscript. Results are nevertheless available upon request.

instance, for the item "Wai-Hin and Connie have shared an office for years but Wai-Hin gets a new job and Connie loses contact with her. What action would be the most effective for Connie?", the most appropriate response is "Contact Wai-Hin and arrange to catch up but also make friends with her replacement." The test-rest reliability of the full version of the test is 0.85 (Libbrecht & Lievens, 2012).

2.2.3. The Geneva Emotion Recognition Test short version (GERT-S) (Schlegel & Scherer, 2016)

The GERT-S is a 42-item performance-based test that measures respondent's ability to recognize others' emotions in the face, voice, and body. It consists of 42 short video clips with sound (duration 1–3 s), in which professional actors express 14 different emotions. Following each clip, respondents are asked to choose which of the 14 emotions was expressed by the actor. Responses are scored as correct or incorrect. The Cronbach alpha was 0.79 in our sample.

2.2.4. The Affect Intensity Measure Short Form AIM-SF (Larsen, 1984)

The AIM-SF is a 20-item inventory that examines emotional reactions to typical life events, such as "I get upset easily". Respondents are asked to rate on a Likert scale, ranging from *1* = *Never* to *6* = *Almost always*, how often they react in a described way. The AIM provides an overview of how strongly or weakly an individual usually experiences emotions. The Cronbach alpha was 0.75 in our sample.

2.2.5. Brief Mood Introspection Scale (BMIS) (Mayer & Gaschke, 1988)

We assessed the participants' emotional state before the DP task with the item "Overall, your mood right now is", from the BMIS. Participants answered using a scale ranging from *0* = *Very unpleasant* to *10* = *Very pleasant*.

2.2.6. The shortened Raven's Standard Progressive Matrices (RSPM, Raven et al., 1998)

Participants' fluid intelligence was assessed with a short version of the RSPM. We selected 36 items from the original RSPM (Set B, C, D) becoming progressively more difficult. In this task, each item presents a matrix of black and white patterns. Respondents are required to infer which missing pattern among 6 or 8 possible choices is the correct one that continues the series. Responses are scored as correct (1) or incorrect (0). Participants had a 5-min time limit to answer the maximum number of items. The Cronbach alpha was 0.92 in our sample.

2.3. Materials

2.3.1. Emotional and neutral faces

As cues in the DP task, we used 16 angry, 16 happy and 32 neutral colored faces from the Karolinska Directed Emotional Faces (Lundqvist et al., 1998). We selected the most intense and arousing validated expressions of anger and happiness from series A and paired them with the corresponding neutral expression (Goeleven et al., 2008, angry: $M_{\text{int}} = 6.7$, $SD_{\text{int}} = 0.6$, $M_{\text{ar}} = 4.1$, $SD_{\text{ar}} = 0.6$; happy: $M_{\text{int}} = 6.9$, $SD_{\text{int}} = 0.3$, $M_{\text{ar}} = 4.1$, $SD_{\text{ar}} = 0.3$; neutral: $M_{\text{int}} = 4.7$, $SD_{\text{int}} = 0.4$, $M_{\text{ar}} = 2.6$, $SD_{\text{ar}} = 0.3$). Using Adobe Photoshop Element 2021, all stimuli were cropped into a standard oval shape concealing hair and external features. The faces' eyes were aligned horizontally at the same height. All stimuli had the same size (346 × 460 pixels, or approximately 12 × 16 cm) and had similar skin tone.

2.3.2. Dot-probe task

The original version of the DP task (Posner, 1980) was modified to evaluate attentional bias towards emotional stimuli. During the task (Fig. 1), a fixation cross appeared at the center of the screen for 750 ms followed by a pair of an emotional (angry or happy) and a neutral expression of the same model. The pair of faces was presented during 100 ms followed by a 100 ms blank screen. Next, a probe appeared with equal chance at the location of the emotional face (emotional condition) or the neutral face (neutral condition). The probe consisted of the letter "F" or "H", and participants were instructed to report the letter by pressing "F" or "H" on the keyboard. Letters remained visible for 3000 ms or less if the participant responded earlier. Reaction time to correct answers was recorded. The task started with 8 practice trials followed by feedback on performance. Then, the main task was composed of 4 blocks of 32 trials. Blocks contained equal numbers of angry-neutral and happy-neutral pairs as well as equal numbers of male and female models. The order was randomized in each block. Between blocks, participants could take a break of 30 s and look again at the instructions or continue the task. To keep the participants motivated throughout the task, they were informed that they would get feedback about their performance at the end of the task. The experiment was run online with the Gorilla interface (https://gorilla.sc) and was restricted to Chrome and Edge users as these browsers have been shown to have more precise presentation visual delay across macOS and Windows operating systems (Anwyl-Irvine et al., 2020).

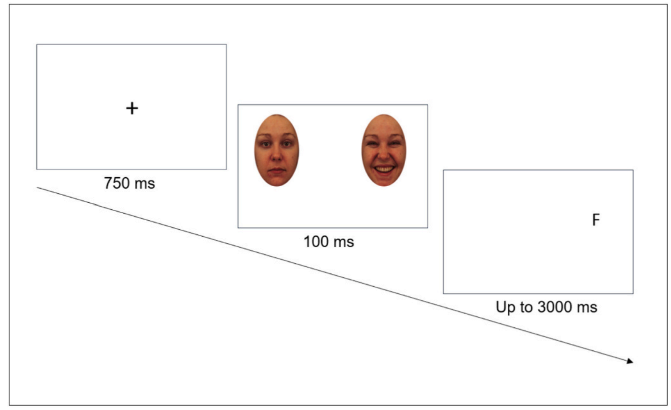

Fig. 1. Example of a trial in the attentional task. In this case, the letter F replaces the emotional face. This corresponds to the emotional condition.

3. Results

3.1. Data preprocessing

Following the criteria set in the pre-registration, two participants with less than 80 % correct responses in the DP task were excluded from the analyses. The analyses were performed only on reaction times (RT) associated with correct responses (4.3 % of the responses were incorrect). Reaction times under 200 ms and above 2500 ms were removed (0.1 % of the data) first and reaction times deviating more than 3sd from each participant's mean in each condition were then eliminated (1.5 % of the data).

3.2. Descriptive statistics and correlations between variables

Mean, standard deviation, and Pearson correlations for all variables are shown in Table 1. Correlations among ability EI measures ranged from 0.30 to 0.59. Intelligence was negatively correlated with Age (−0.22) and positively correlated with EI measured by the Situational Test of Emotion Understanding (STEU; 0.18) and the Geneva Emotion Recognition Test (GERT; 0.22). Mood was only correlated with the GERT (−0.23). RTs in both conditions were negatively correlated with Age, Intelligence and the three facets of EI. AIM did not correlate with any facet of EI or reaction times.

3.3. Reaction times analysis

We now turn to the main hypothesis of this study, which is that as EI increases, there should be larger differences between RTs in the

Table 1
Descriptive statistics and correlations for the variables in the study.

	M	SD	1	2	3	4	5	6	7	8
1. Age	28.9	9.8								
2. Raven	19.5	5.2	−0.22**[a]							
3. Mood	6.5	1.8	0.12	−0.10						
4. STEU	0.6	0.1	−0.04	0.18*	−0.14					
5. STEM	0.6	0.1	−0.01	0.15	−0.04	0.30***				
6. GERT	24.4	6.1	−0.10	0.22**	−0.23**	0.59***	0.38***			
7. AIM	75.6	11.5	−0.14	−0.09	0.05	0.04	0.06	0.01		
8. RT_emo	521.4	93.2	0.31***	−0.42***	0.21**	−0.26***	−0.20*	−0.32***	0.01	
9. RT_neu	521.5	91.5	0.30***	−0.40***	0.23**	−0.24**	−0.17*	−0.31***	0.01	0.97***

[a] Note: STEU: Situational Test of Emotion Understanding, STEM: Situational Test of Emotion Management, GERT: Geneva Emotion Recognition Test, AIM: Affect Intensity Measure, RT_emo: Response time in emotional condition, RT_neu: Response time in neutral condition. *$p < .05$, **$p < .01$, ***$p < .001$

emotional and neutral conditions. Our data were analyzed using Linear Mixed-Effects (LME) models (Baayen et al., 2008; Bates et al., 2015) with the statistical software R (R Core Team, 2021).

According to the Box Cox test's result, (Box & Cox, 1964), RTs were inverse transformed to account for their distribution. In all models, sum coding was used to define the contrasts of Condition, with −1 corresponding to neutral. All continuous independent variables were standardized around the grand mean.

3.4. Emotion understanding facet of EI

We fitted an LME model with inverse RT as the outcome variable, with fixed effects of age, gender,[3] mood, intelligence, and trial number (since RTs are known to get faster throughout the experiment) as control variables, and condition (neutral vs. emotional), STEU and their interaction as key explanatory variables. First, we fitted a maximal random effects structure, which included random intercepts and slopes for condition by participant, but no correlation between the random terms. As the model had singular fit, we performed a Principal Component Analysis of the random-effects variance-covariance estimates as advised by Bates et al. (2015) and simplified the model accordingly. The final model included random intercepts for participants (full outputs of reported models are reported in the supplemental material).

The model (see Table A.1 in the supplemental materials) revealed significant effects of age, intelligence, trial number and STEU. Reaction times increased with age but diminished as a function of intelligence, trial number and STEU. As hypothesized, the effect of STEU was qualified by a STEU by condition interaction. When inspecting the interaction, it appeared that it could be better described by a non-linear relationship. We therefore added the quadratic term for STEU in the model. This model showed significant effects of age ($\beta = 0.76$, $SE = 0.20$, $p < .001$), intelligence ($\beta = -0.87$, $SE = 0.20$, $p < .001$), trial number ($\beta = -0.21$, $SE = 0.03$, $p < .001$), STEU (linear term:$\beta = -60.38$, $SE = 27.41$, $p = .029$), and the STEU by condition interaction (linear term: $\beta = -7.66$, $SE = 3.56$, $p = .032$, quadratic term: $\beta = -9.08$, $SE = 3.56$, $p = .011$). This means that condition influenced RT only at certain levels of the understanding facet of EI. A model (see Table A.2 in the supplemental materials) with shifted values of STEU (+1sd) revealed a significant effect of condition ($\beta = -0.08$, $SE = 0.04$, $p = .03$), meaning that, among our participants, only those with a high score on the STEU showed faster RT in the emotional compared to the neutral condition (Fig. 2), which is consistent with Hypothesis 1.

In order to test whether the attentional bias was related to the emotion expressed on the emotional faces, we fitted a similar model, adding emotion (happiness vs. anger) in the interaction term (STEU × Condition × Emotion). The three-way interaction was not significant, suggesting that our results did not depend on the valence of the emotion presented. Additional analyses on the happiness and anger subsets revealed that even though the STEU by condition interaction was significant in both subsets, condition started to influence RT at lower levels of STEU for angry (+0.5sd) compared to happy faces (+1.5sd) (see Tables A.3 and A.4 as well as Fig. A.1 in the supplemental materials).

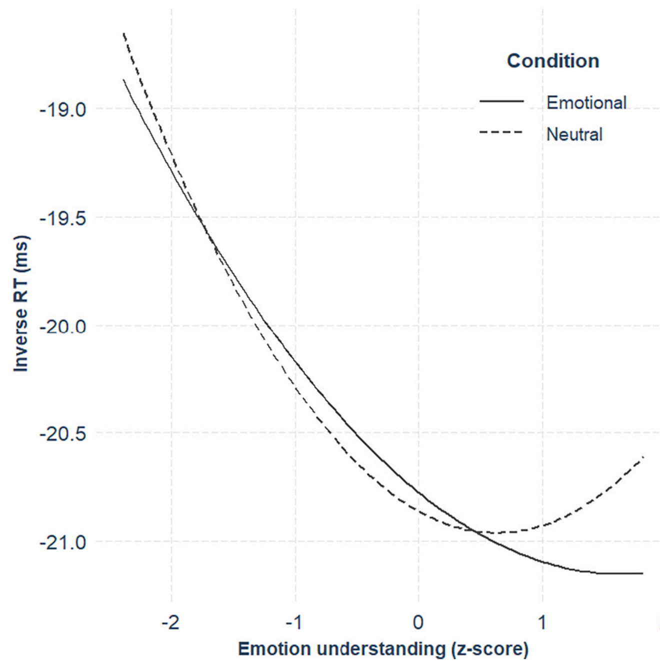

Fig. 2. Inverse RTs as a function of condition and STEU score (standardized).

3.5. Emotion recognition and management facets of EI

Similar models to those presented for the STEU were fitted with either the STEM or the GERT scores in interaction with Condition. They did not show any main effect of condition or EI nor significant interaction effect between EI and condition.

3.6. Affect intensity measure

To test hypothesis 2, a similar model to those including EI was fitted with AIM. Contrary to our hypothesis, the model did not reveal any effect involving AIM (see Table A.5 in the supplemental materials).

4. Discussion

This study tested the hypersensitivity hypothesis (Fiori & Ortony,

[3] Two participants indicated « other » for this variable. For this reason, they were not considered in the first fitted models which showed no significant effect of Gender. Gender was then removed from the model and the two participants were added back in the following models.

2021) that high-EI individuals are characterized by hypersensitivity to emotion information. We operationalized hypersensitivity as an attentional bias to emotion information and measured it with a DP task. We found that individuals high on the emotion understanding facet of EI (+1 sd) were faster to react in the emotional as compared to the neutral condition. Our results suggest that there might be a critical level in emotion understanding after which individuals are biased towards emotional information, even when endogenous attention is supposed to be directed towards neutral information.

Of note, the attentional bias to emotional expressions was found only for emotion understanding, which is the EI component that loads more strongly into EI (MacCann et al., 2014), and seems to capture the most variability in EI performance (see, for example, Udayar et al., 2020). The fact that emotion recognition assessed by the GERT did not influence the attentional bias for emotional expressions might seem counterintuitive at first, as this component is notably related to the processing of emotional cues displayed in facial expressions. The very nature of the task used in this study, tackling automatic attention allocation processes related to emotion perception rather than more elaborate processes related to emotion recognition, may explain this finding.

Surprisingly self-reported sensitivity to emotions measured by the Affect Intensity Measure (AIM) did not influence attentional bias to emotions in the DP task. A possible explanation is that the former is based on subjective perceptions about one's characteristics, and on reflective and not time-constrained type of reasoning, whereas the latter represents objective performance in emotional tasks based on spontaneous treatment of emotion information. The fact that AIM was also not correlated to any measure of EI suggests that it is not related neither to emotional abilities nor to the emotional processes involved in EI_p. This is not particularly surprising given the literature showing low to non-significant correlations between explicit and implicit measures of psychological constructs (e.g., Köllner & Schultheiss, 2014).

The current study suggests that emotional hypersensitivity can be revealed by differences in initial orienting to emotional content. It showed that individuals high in EI, particularly emotion understanding, do have a preference (or bias) for emotional as compared to neutral information. Of note, although this type of attentional bias is well known in the literature on emotional disorders (e.g., Bar-Haim et al., 2007), in our task the effect was found for both positive and negative emotional expressions, indicating no specificity of emotional valence as far as it regards the hypersensitivity associated with high EI. This lack of emotion specificity in the attentional bias suggests that high EI individuals might direct attention to threatening stimuli because of their adaptability-related relevance, and to positive stimuli for their protective effect against stress. Of note, the occurrence of both biases at the same time has been linked to higher resiliency (Thoern et al., 2016).

5. Limitations and future directions

The attentional bias found in this study–occurring after 100 ms of stimulus presentation and followed by 100 ms stimulus onset asynchrony (SOA)–corresponds to the first attentional shift. Previous research has shown that stimulus duration and SOA modify attentional bias (Koster et al., 2004). Further research is needed to test how attentional bias related to EI is modulated by different stimuli and SOA duration. Further research might test whether a form of emotional hypersensitivity related to EI may be identified in the inhibitory mechanism involved in attentional disengagement from emotional expressions. Another line of research might employ subliminal cues to trigger emotional hypersensitivity.

In our study the phenomenon of hypersensitivity was only evoked by intense emotional facial expressions. Previous research has shown that stimulus type (Pishyar et al., 2004) and intensity (Koster et al., 2004; Koster et al., 2006) and arousal (Pool et al., 2016) may modify attentional bias. Consequently, it might be interesting to replicate the current study using various emotional expressions different from happiness and anger and/or emotions elicited by emotional scenes varying along the intensity continuum.

Results lend support to the hypersensitivity hypothesis according to which EI works by amplifying the attention and depth of processing of emotion information and its impact on (social) perception. Beyond further understanding how hypersensitivity may unfold in high EI individuals, for example employing other emotion-information processing tasks that capture perceptual or memory related processing of emotion information, further research might address the implications of this way of functioning of EI. Is hypersensitivity an asset or a limitation in social behavior? For instance, if high EI individuals do pay special attention to emotional expressions, can this heightened attention distract from other tasks? Can hypersensitivity provide a fine-grained interpretation of the emotional world that may ultimately support more adaptive behavior? These and other related research questions will help to understand more in-depth what EI is about and the way it impacts important life outcomes.

CRediT authorship contribution statement

CG: study design, data analyses, writing; MNdF: study design, data analyses, writing; MM: feedback on study design and methodological advice; DS: feedback on study design and methodological advice; MF: funding acquisition, study conceptualization, writing.

Data availability

Data and the script for statistical analyses conducted in the paper can be found following the OSF link.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.paid.2022.111917.

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