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Impairment in reading negative social cues extends beyond the face in autism

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ABSTRACT

Nonverbal expressions are essential to regulating social communication and interaction. Impaired emotion recognition from facial expressions has been linked to various psychiatric conditions characterized by severe social deficits such as autism. As body expressions as an additional source of social-emotional information have attracted little research attention, little is known about whether emotion recognition impairments are specific to faces, or extend to body expressions. This study explored and compared emotion recognition from face versus body expressions in autism spectrum disorder. We compared 30 men with autism spectrum disorder to 30 male age- and IQ-matched control participants in their ability to recognize angry, happy, and neutral expressions from dynamic face and body expressions. Participants with autism spectrum disorder showed impaired recognition of angry expressions from both faces and bodies, while there were no group differences in recognizing happy and neutral expressions. In autism spectrum disorder, recognizing angry face expressions was inversely predicted by gaze avoidance, while recognizing angry body expressions was inversely predicted by impairments in social interaction and autistic traits. These findings suggest that distinct mechanisms may underlie the impaired emotion recognition from face and body expressions in autism spectrum disorder, respectively. Overall, our study demonstrates that emotion-specific recognition difficulties in autism spectrum disorder are not limited to face expressions but extend to emotional body expressions.

1. Background

The ability to infer the emotional state of others from their nonverbal expressions and react appropriately is crucial for successful social interaction. Impaired emotion recognition is associated with various psychiatric conditions including autism spectrum disorder (ASD), schizophrenia, depression, social anxiety, and borderline personality disorder (Uljarevic and Hamilton, 2013; Kohler et al., 2010; Dalili et al., 2015; Chen et al., 2020; Daros et al., 2013). Although the whole body is a potential source of nonverbal information, the vast majority of emotion recognition research has focused on (static images of) faces (Uljarevic and Hamilton, 2013; also see Black et al., 2017). ASD has been linked with serious impairments in recognizing negative facial cues like anger and fear expressions, but only marginal impairments in recognizing happy faces (Lozier et al., 2014; Uljarevic and Hamilton, 2013). Although studies exploring the recognition of body expressions are scarce in comparison, converging evidence from studies in children (e.g., Hubert et al., 2007; Mazzoni et al., 2020; Parron et al., 2008) and adults with ASD (e.g., Alaerts et al., 2015; Atkinson, 2009; Hadjikhani et al., 2009; Nackaerts et al., 2012; Mazzoni et al., 2022) suggests that emotion recognition impairments in ASD might not be limited to faces, with mixed findings regarding which specific emotions are affected. However, little is known about how findings on emotion recognition from faces and bodies relate, as studies exploring the two in conjunction are scarce in both ASD (e.g., Fridenson-Hayo et al., 2016; Philip et al., 2010) and the general population (e.g., Actis-Grosso et al., 2015; Calbi et al., 2017; Martinez et al., 2016; Willis et al., 2011). This apparent research gap might be attributable to methodological barriers.

Lacking established face-and-body tasks, previous studies drew face and body stimuli from different tasks. As a consequence, face and body stimuli were not matched in their psychometric properties such as difficulty, number of items, or score variance. The tasks thus differed in

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their sensitivity in capturing impairments (see Chapman and Chapman, 1978, 2001). For example, virtually all individuals can perform well on a very easy task (see Smith et al., 2010; Suzuki et al., 2006) – a phenomenon well known from emotion recognition research. As happiness is the easiest emotion to recognize from the face, recognition performance is typically close-to-maximum, even in participants with ASD (e.g., Russell, 1994; Boraston et al., 2007; Enticott et al., 2013). As angry faces are harder to recognize (see Russell, 1994), impairments might be more readily detected (see Smith et al., 2010; Suzuki et al., 2006). To accurately reflect differences in *ability* rather than task characteristics, psychometrically matched tasks are needed (Chapman and Chapman, 1978, 2001).

Furthermore, the evident methodological bias towards faces might limit our understanding of the social mind. Many individuals affected by psychiatric conditions are disadvantaged when presented with face tasks, as they perceive eye contact as aversive and hence avoid looking at the eye region (Kret et al., 2017; Schneier et al., 2011; Tottenham et al., 2014; Trevisan et al., 2017; Wang et al., 2018; also see Stuart et al., 2023). Since both gaze avoidance (Madipakkam et al., 2017; Papagiannopoulou et al., 2014; Tottenham et al., 2014; Trevisan et al., 2017; also see Stuart et al., 2023) and impaired emotion recognition from faces (Lozier et al., 2014; Uljarevic and Hamilton, 2013) are highly prevalent in ASD, a causal relationship between the two has been proposed in the *eye avoidance hypothesis of autism* (Tanaka and Sung, 2016). The gaze is not just a powerful social signal conveying information about the self (e.g., aggression or social engagement during a conversation; see Frischen et al., 2007), it also modulates attention to available nonverbal cues: Recognition of angry and other negative face expressions strongly depends on the eyes, while recognizing happy faces depends mostly on the mouth (Calder et al., 2000; Calvo et al., 2018; Eisenbarth and Alpers, 2011; Scheller et al., 2012; Smith et al., 2005; Wallace et al., 2008). Consequently, emotion-specific recognition impairments in ASD might be explained by the incomplete processing of available nonverbal information due to gaze avoidance (Tanaka and Sung, 2016). Although this hypothesis offers a straightforward and compelling framework for understanding emotion recognition impairments in ASD, research has challenged its validity, especially in the context of facial emotion processing, and has brought up alternative explanations for reduced eye gaze (e.g., lack of social salience; Helminen et al., 2017; Lauttia et al., 2019; Moriuchi et al., 2017; Nuske et al., 2015; but see also Stuart et al., 2023). Moreover, it has been suggested that impaired facial emotion recognition is instead linked to the severity of autistic symptoms, rather than aberrant gaze patterns (e.g., Bal et al., 2010; also see Black et al., 2017). Yet to better understand wheather ASD impairments in emotion recognition are specific to faces or a facet of a broader disruption of social cognition, it seems crucial to include stimuli other than faces.

To close this research gap, we explored and systematically compared emotion recognition from the face versus body expressions in ASD applying psychometrically matched tasks. For faces, we hypothesized that ASD would be linked with impairments in recognizing angry but not happy or neutral face expressions, and that gaze avoidance would predict the recognition of angry face expressions. We also explored the recognition of angry, happy, and neutral body expressions and specifically compared participants' recognition performance between face and body expressions.

2. Material and methods

2.1. Participants

Appropriate sample size was determined based on an a priori power analysis (see supplementary material). We recruited 30 men (age 20–61, nonverbal IQ 80–144) who met DSM-5 criteria for ASD. Diagnoses were validated by a clinically trained interviewer (see *Procedure*). The control group consisted of 30 healthy men without ASD (age 21–60, nonverbal IQ 86–156) recruited via flyers and mailing lists. Groups were matched for age and intelligence (see Table 1).

2.2. Measures

Participants viewed tasks and questionnaires on a standard laboratory computer using jsPsych (de Leeuw, 2015).

Emotion recognition from face and body expressions was measured using the EmBody/EmFace (Lott et al., 2022). The EmBody subtask comprises videos of body expressions shown as point-light displays. The EmFace subtask comprises videos of dynamic face expressions. Both subtasks include angry, happy, and neutral expressions (42 total per subtask, 14 per emotion), half of which are shown from frontal and half-profile view, respectively. For each video, participants select which of the three emotions they believe was being portrayed. Performance is measured as the proportion of correct responses. Since the two subtasks were matched for difficulty and other properties, individual performances can be compared directly between them.

Impairments in social communication and social interaction were quantified using observer ratings from the Autism Diagnostic Observation Schedule-Second Edition (ADOS-2; Poustka et al., 2015; see *Procedure*). Broader autistic symptoms were quantified using the Autism-Spectrum Quotient (Baron-Cohen et al., 2001). Gaze anxiety and gaze avoidance were quantified using the Gaze Anxiety Rating Scale (Domes et al., 2016; Schneier et al., 2011), a self-report measure designed to assess anxiety and avoidance a person experiences around making eye contact in different social situations (e.g., receiving a compliment, giving a speech, or dealing with a cashier when buying something). Symptoms of alexithymia (i.e., inability to recognize and describe one's own feelings) were quantified via the 20-item Toronto Alexithymia Scale (Bagby et al., 1994). Table 1 shows the descriptive statistics of these measures, including significance levels of group differences (based on independent samples *t*-tests) and effect sizes of group

Table 1
Group characteristics and significance tests for group differences.

	Autistic group (n = 30)	Control group (n = 30)	Group difference	
			p	Cohen's d
Age	34.0 ± 10.2	34.6 ± 10.1	.83	−.06 [−.56, .45]
$IQ_{Nonverbal}$	116.2 ± 17.2	118.5 ± 15.9	.58	−.14 [−.65, .36]
IQ_{Verbal}	110.4 ± 10.0	110.7 ± 7.4	.92	−.03 [−.53, .48]
Impairments in social communication	3.8 ± 1.3	0.2 ± 0.4	<.001	3.79 [2.93, 4.64]
Impairments in social interaction	7.0 ± 2.2	0.2 ± 0.6	<.001	4.33 [3.39, 5.26]
Autistic traits	36.3 ± 7.0	17.0 ± 5.9	<.001	2.99 [2.24, 3.73]
Gaze avoidance	22.5 ± 9.5	7.4 ± 6.3	<.001	1.87 [1.26, 2.48]
Gaze anxiety	16.7 ± 9.9	7.3 ± 6.1	<.001	1.15 [0.60, 1.69]
Alexithymia	58.4 ± 14.0	40.1 ± 8.3	<.001	1.58 [1.00, 2.16]

Note. Values in square brackets indicate the 95% confidence interval of the observed effect.

differences represented by Cohen's *d* with their 95% confidence interval.

As the relevance of controlling for potential confounding variables has been emphasized in previous publications (Atkinson, 2009; Cuve et al., 2018; also see Black et al., 2017), we additionally measured basal motion perception to ensure all participants were capable of recognizing motion from dynamic stimuli (for a discussion, see Atkinson, 2009; Philip et al., 2010). In the ASD group, we additionally assessed medication intake and prior experience with social skills training (e.g., through webinars; see supplementary material).

2.3. Procedure

Our study was approved by the Ethics Committee of the University of Freiburg and adhered to the Declaration of Helsinki. All participants provided informed consent and were reimbursed for their time (50€). We screened all participants prior to the study (see supplementary material) and conducted diagnostic interviews to ensure their eligibility for participation. A trained interviewer administered Module 4 of the German version of the ADOS-2 (Poustka et al., 2015) to validate group allocation. The ADOS-2 assesses four domains: Social Communication, Social Interaction, Imagination/Creativity, and Restricted and Repetitive Stereotyped Behaviors and Interests. Following the manual's guidelines, participants had to meet the cutoff values in the Communication domain (score $\geq$2), Interaction domain (score $\geq$4), as well as in the Communication + Interaction domain (score $\geq$7; Poustka et al., 2015) to receive an ASD research diagnosis. The Imagination/Creativity, and Restricted and Repetitive Stereotyped Behaviors and Interests domains are not considered in the final scores. In addition, the interviewer administered the Structured Clinical Interview for DSM-5, Clinician Version (SCID-5-CV; Beesdo-Baum et al., 2019) to ensure the absence of current psychiatric conditions (e.g., depression or social anxiety disorder), with the exception of mild symptoms of attention-deficit hyperactivity disorder in the ASD group if successfully managed with medication. Two individuals failed to meet the criteria for an ASD research diagnosis as determined by the ADOS-2 and were therefore excluded from participation (see flow chart of study inclusion in Fig. S1). All participants underwent intelligence testing, in which Part 1 of the Culture Fair Test (CFT 20-R; Weiβ, 2006) was used to assess nonverbal IQ and a multiple-choice vocabulary test (Schmidt and Metzler, 1992) was used to assess verbal IQ, respectively, to ensure IQ-matching (see Table 1). On the study day, participants were tested in a quiet laboratory room and completed the EmBody and EmFace as well as the questionnaires with no time limit. When two separate visits to the laboratory were not possible, participants completed the tasks and questionnaires after a break following the diagnostic interviews and intelligence tests.

2.4. Statistical analysis

To explore whether the ASD and control group differed in their ability to recognize emotional faces and bodies, we performed a mixed ANOVA in IBM SPSS Statistics 27 with the between-subject factor group (ASD group, control group) and the within-subject factors emotion (angry, happy, neutral) and stimulus type (face, body). The proportion of correct responses served as the outcome. Greenhouse-Geisser correction was applied whenever the sphericity assumption was violated. Bonferroni-adjusted significance tests were used for pairwise comparisons to explore interaction effects. Within the ASD group, we conducted additional analyses to control for the effects of basal motion perception, medication intake and prior interventions (see supplementary material).

3. Results

3.1. Impaired recognition of anger from both face and body expressions in ASD

A significant two-way interaction group × emotion (F[1.45, 84.25] = 6.53, p = .006, $\eta_p^2 = 0.10$) suggested the presence of emotion-specific group differences in recognition performance (the significant main effect of group, F[1, 58] = 5.06, p = .028, $\eta_p^2 = 0.08$, could not be interpreted further in the presence of the significant disordinal interaction). Pairwise comparisons revealed that recognizing angry expressions was significantly worse in the ASD group compared to the control group (−15.8% [95% CI, −25.7% to −6.0%], p = .002). This anger-specific effect appeared to be independent of stimulus type, as the three-way interaction group × emotion × stimulus type did not reach statistical significance (F[1.96, 115.69] = 0.25, p = .78, $\eta_p^2 = 0.004$). Fig. 1 illustrates recognition performance and shows group comparisons separately for the two stimulus types. Recognition performance for happy face and happy body expressions did not differ significantly between the two groups (smallest p = .19 for the group comparison for happy face expressions). Likewise, we observed no significant differences between groups in recognition performance for neutral face and neutral body expressions (smallest p = .19 for the group comparison for neutral faces). Further testing within the ASD group indicated that the recognition of angry face and body expressions correlated significantly with one another (r_S [29] = 0.58, p < .001) and that impairments were equivalent across the two modalities (see supplementary material).

3.2. Anger recognition from face versus body expressions is explained by different variables in ASD

To further investigate the nature of the anger-recognition impairments we had identified within the ASD group, we computed correlations between anger recognition from face and body expressions, respectively, and potential predictors including observer ratings of impairments in social communication and impairments in social interaction as well as self-reported autistic traits, gaze avoidance, gaze anxiety, and alexithymia. Anger recognition from face expressions revealed a significant negative correlation with self-reported gaze avoidance (r_S[29] = −0.52, p = .003), while anger recognition from body expressions showed significant negative correlations with objective impairments in social interaction (r_S[29] = −0.41, p = .025) and self-reported autistic traits (r_S[29] = −0.38, p = .038). The remaining non-significant correlations are found in the supplementary material. We also computed the respective correlations in the control group where the only significant association was found between anger recognition from body expressions and self-reported autistic traits (r_S[29] = −0.38, p = .037). A comparison of the correlation coefficients in the ASD and the control group using Fisher's r-to-z transformation (see Sheshkin, 2004; Zar, 1999) suggested that the correlations did not differ significantly between groups (z = −0.008, p = .99).

To test how much of the variance in anger recognition performance observed within the ASD group could be explained with the respective variables, we computed two multiple linear regressions using recognition performance from angry face and angry body expressions, respectively, as the outcome measures, and added the variables demonstrating significant correlations in the respective regression model using the enter method. For angry face expressions, self-reported gaze avoidance as a single predictor (β = −.54, t[28] = −3.38, p = .002) explained a significant proportion of observed variance in recognition performance (R^2 = 29%, adjusted R^2 = 26%, F[1,28] = 11.39, p = .002). The relationship between self-reported gaze avoidance and recognition performance for angry face expressions is shown in Fig. 2a. For angry body expressions, objective impairments in social interaction (β = −.41, t[28] = −2.48, p = .02) and self-reported autistic traits (β = −0.35, t[28] = −2.15, p = .04) both inversely predicted recognition performance,

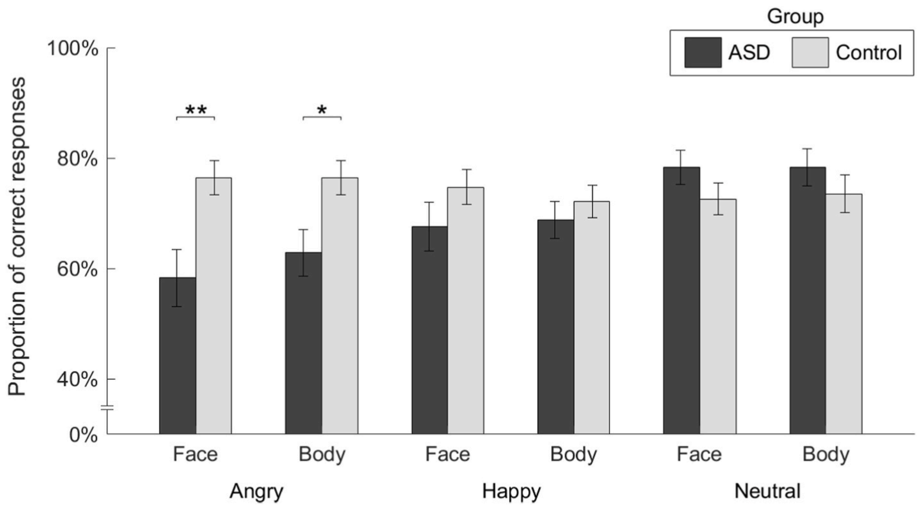

Fig. 1. Mean emotion recognition performance, measured as the proportion of correct responses, plotted for angry, happy, and neutral face and body expressions, depicted separately for the autism spectrum disorder (ASD) group and control group. Error bars depict the standard error of the mean. Asterisks mark group differences computed separately for each stimulus type significant at $p < .05$ (*) and $p < .01$ (**), respectively (adjusted for multiple comparisons using Bonferroni correction).

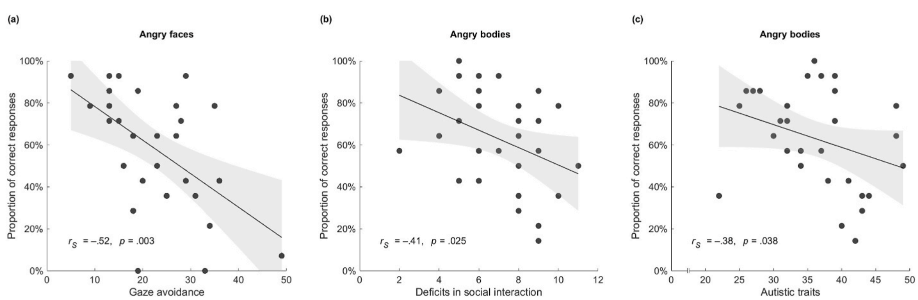

Fig. 2. Scatter plots depicting the relationship between emotion recognition performance, measured as the proportion of correct responses, shown for the association (a) angry face expressions and gaze avoidance, (b) angry body expressions and impairments in social interaction, and (c) angry body expressions and autistic traits within the autism spectrum disorder (ASD) group. The solid line represents the fitted regression line, shaded bands indicate 95% confidence bounds of the fitted line. r_S = Spearman rank correlation.

together explaining a significant proportion of variance ($R^2 = 27\%$, adjusted $R^2 = 22\%$, $F[2,28] = 5.02$, $p = .01$). The relationships between the two variables and recognition performance for angry body expressions are shown in Fig. 2b and c.

4. Discussion

This is the first study to directly compare emotion recognition from face versus body expressions in ASD using difficulty-matched tasks. Our study provides initial evidence that the anger-recognition impairments in ASD previously described for faces (Uljarevic and Hamilton, 2013) are not face-specific but extend similarly to the body, whereas the recognition of happy expressions appeared generally unaffected. These findings add to the literature on emotion recognition, as previous studies that used body stimuli yielded heterogeneous findings about the specific emotions whose recognition is impaired in ASD (e.g., Atkinson, 2009; Mazzoni et al., 2020, 2022). While happy expressions signal safety and invite social approach, angry expressions function as social-threat signals prompting their 'recipient' to either respond angrily as well (i.e., fight) or retreat from the interaction (i.e., flight; Darwin, 1872). Consequently, failure to correctly identify negative social cues and react appropriately could have detrimental effects on social functioning, potentially explaining why individuals with ASD experience interpersonal conflicts, bullying, and social isolation more often throughout life (Blacher et al., 2014; Scott et al., 2017; Cappadocia et al., 2012; Van Roekel et al., 2010; Orsmond et al., 2013).

Given the parallel impairments in reading face and body expressions, our findings challenge the current view on mechanisms underlying emotion recognition difficulties in ASD. For face expressions, our findings seem to support the eye avoidance hypothesis (Tanaka and Sung, 2016). Recognizing angry faces depends crucially on the eyes, while recognizing happy faces largely depends on the mouth (Calder et al., 2000; Calvo et al., 2018; Eisenbarth and Alpers, 2011; Scheller et al., 2012; Smith et al., 2005). Thus, the observation of impaired recognition of angry but not happy faces seems plausible. Further support comes from our observation that stronger self-reported gaze avoidance was associated with more serious impairments in recognizing angry faces. However, the eye avoidance hypothesis falls short in explaining why circumscribed anger-recognition impairments affect the recognition of both face and body expressions. Strikingly, impaired anger recognition from bodies was best predicted by two measures of autistic symptoms, suggesting that these impairments persist even without a substantial contribution from self-reported gaze avoidance. In this, our findings are in line with previous eye-tracking evidence suggesting that ASD-related impairments in anger recognition are independent of gaze patterns and are instead linked to symptom severity (Bal et al., 2010). Overall, our findings emphasize that the link between gaze avoidance and emotion recognition in ASD might be more complex than previously thought, highlighting the need for further research on this matter. Interestingly, anger recognition from bodies was also negatively linked to autistic traits in our control group, mirroring studies reporting this association for facial emotion recognition in healthy individuals (e.g., Lott et al., 2022; McKenzie et al., 2018). These findings support recent theories of ASD that conceptualize autistic traits as distributed along a continuum in the population and thus question discrete diagnostic categories (Bailey et al., 1995; Baron-Cohen et al., 2001; also see Eapen et al., 2013).

Furthermore, our findings might have several clinical implications. Many non-pharmacological interventions designed to alleviate social impairments in ASD focus on increasing eye contact (e.g., Palmen et al., 2012; Sartorato et al., 2017). However, the rationale behind targeting gaze behavior as an outcome differs depending on the individual's age. For children with ASD, interventions are usually based on the concept of *gaze indifference*: Reduced eye contact, presumably reflecting lack of interest in social stimuli, is thought to hamper the development of emotion-recognition abilities by minimizing social learning opportunities (Chevallier et al., 2012; Clements et al., 2018). Since reduced eye contact is not observed right after birth but rather develops within the first months of life (Jones and Klin, 2013), cueing and reinforcing eye contact during critical developmental time windows is a plausible strategy to shape the developing social brain. For adults with ASD, interventions are usually based on the concept of *gaze aversion*: Since adults with ASD frequently report discomfort during eye contact (Dalton et al., 2005; Hadjikhani et al., 2017; Trevisan et al., 2017; also see Livingston and Happé, 2017), gaze avoidance is considered a mechanism to prevent or reduce discomfort (see Stuart et al., 2023). Aiming to increase visual exploration of the eye region seems plausible only when we assume that gaze avoidance *causes* impairments in recognizing emotional faces, as the eye-avoidance hypothesis suggests (Tanaka and Sung, 2016). However, evidence from an eye-tracking study suggests that impairments in recognizing emotional faces prevail even when adults with ASD are forced to examine the eye region and spend as much time exploring it as control participants (Sawyer et al., 2012). Without evidence for successfully restoring emotion recognition, encouraging individuals with ASD to increase eye contact and disregard their experience of discomfort might not be fruitful (see Sawyer et al., 2012). Our study proves that standardized body stimuli, like standardized face stimuli, are sensitive to interindividual differences in symptom severity and can reliably detect emotion recognition impairments (see Lott et al., 2022). As body stimuli appear to tap into similar social processing mechanisms as face stimuli, presumably without adding discomfort or distress linked to exploring the eye region (see Dalton et al., 2005), they might offer a preferable means of assessment.

While this study provides valuable insights into emotion recognition from the face and body, it is important to acknowledge its limitations. First, our study focused on only two emotions, namely anger and happiness. This is insofar beneficial, as angry and happy bodily expressions share basic kinematic properties such as speed and jerkiness. As a result, they are not easily distinguished by observers based on motion cues alone but instead require that observers infer emotional meaning (see Lott et al., 2022). Nonetheless, systematically exploring other emotions in future studies will certainly enable a deeper understanding of emotion recognition in ASD. Second, different to other studies that use experimental tasks including eye-tracking or psychophysiological methods, we assessed gaze avoidance via self-reports. As the link between subjective gaze preferences, as assessed using self-reports, and manifest gaze behavior is unclear (Tönsing et al., 2022), further research on this matter is needed. However, our finding that impaired anger recognition from body expressions is linked to the severity of autistic symptoms, rather than self-reported gaze avoidance, is in line with a study that applied eye tracking to study facial emotion recognition (Bal et al., 2010). Third, our study included male participants only. Historically, both behavioral studies on emotion recognition (Griffin et al., 2021; Lozier et al., 2014) and neuroimaging studies exploring the neurobiological correlates of autistic impairments (Clements et al., 2018; Philip et al., 2012) have favored investigating male individuals with ASD, with male-to-female ratios of up to 15:1. These numbers stand in stark contrast to the estimated 3:1 male-to-female ratio in the autistic population (Loomes et al., 2017), suggesting that autistic girls and women are underrepresented in research. It thus seems crucial that both male and female individuals with ASD be enrolled in future studies to better understand the condition as a whole.

Taken together, our findings suggest that emotional face and body expressions provoke similar impairment patterns of emotion recognition in ASD, possibly hinting at shared neural correlates. At the same time, neuroimaging studies provided evidence that the processing of face and body stimuli involves both shared and distinct neural networks (van de Riet et al., 2009; Kret et al., 2011). It therefore seems essential that future studies explore the neural underpinnings of emotion recognition beyond the face. It would be particularly interesting to study how the brain integrates cues from the face and the body, as weak central coherence (i.e., focusing on details instead of seeing the "bigger picture") has been proposed as a potential explanation for the strengths and difficulties observed in ASD (Happé and Frith, 2006). Fruitful insights could also come from research targeting pharmacological interventions aimed at altering the processing of socially relevant stimuli. For example, oxytocin application was found to modulate the attention to emotional faces in ASD (Domes et al., 2013; Fathabadipour et al., 2022; Heinrichs et al., 2009; Kanat et al., 2017; Meyer-Lindenberg et al., 2011). A systematic comparison of how emotional face and body expressions are processed might lead to novel insights into the function of the social mind in health and psychiatric conditions.

Author contributions

L.L.L.-S. conceptualized and designed the experiment, collected and analyzed data, and drafted the manuscript. F.B.S. and M.H. conceptualized and designed the experiment and supervised the study, interpreted data, and drafted the manuscript. All authors approved the final manuscript as submitted.

Declaration of competing interest

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Appendix A. Supplementary data

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