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David Williams

Institute of Child Health, University College London

Francesca Happé,

Social, Genetic and Developmental Psychiatry Research Centre, Kings College London

Correspondence to:

David Williams

Institute of Child Health, University College London

30 Guilford Street, London WC1N 1EH

Telephone: 020 7242 9789

Email: d.williams@ich.ucl.ac.uk

Abstract

Studies of emotion processing in autism have produced mixed results, with fewer studies observing autism-specific deficits than might be imagined. In the current study, 21 individuals with autism and 21 age- and ability-matched, learning disabled comparison participants were tested for their ability to (a) recognise, *in others*, expressions of "social" emotions (e.g., embarrassment) and "non-social" emotions (e.g., happiness) and; (b) report *their own* previous experiences of each of these emotions.

In line with predictions, amongst both groups of participants, social emotions were more difficult to recognise and report than non-social emotions. Also amongst both groups, the ability to report social emotion-experience was significantly associated with the ability to recognise social emotions in others, independent of age and verbal ability. However, contrary to predictions, there were no group differences in the levels or patterns of performance amongst participants with autism and comparison participants.

In light of previous research, these results suggest either that emotion-processing is not as specifically impaired in autism as is traditionally thought to be the case, or that individuals with autism are implementing compensatory strategies to succeed on experimental tasks in the absence of emotion-processing competence.

Keywords: Autism Spectrum Disorder, Emotion Processing, Self-Awareness, Self-Conscious Emotion, Social Emotion.

Introduction

Reports of emotion processing deficits amongst people with autism are not hard to find, either from individuals with autism themselves (e.g., Grandin, 1996), or from their caregivers, or clinicians (e.g., Kanner, 1943; Hobson et al., 2006). Indeed, deficits in emotion processing form part of the diagnostic criteria of autism according to major classification systems (e.g., American Psychiatric Association, 2000) as well as 'gold standard' assessment tools (e.g., Lord et al., 2000). However, when considering the results of well-controlled empirical studies, evidence of autism-specific deficits in recognizing emotions in others, or describing emotions in self, is mixed.

When considering the literature on emotion processing in autism, one important factor to bear in mind regards the *type* of emotion under consideration. For many emotion theorists, 'social' or 'self-conscious' emotions, such as embarrassment, pride, and guilt are a special class of emotion, separate from 'basic' emotions, such as fear, happiness, and sadness (e.g., Levenson, 1999). Although all emotions could be considered 'social' in the most basic sense, emotions like pride, shame, embarrassment, and guilt are assumed to be at least partly culturally constructed and dependent for their emergence on social-affective/social-cognitive capacities, including basic self-other differentiation and the ability to register the perspectives of others on oneself (e.g., Lewis, 2003; Tracy & Robins, 2004). In contrast, basic emotions are widely assumed to emerge early in development and have a biological (innate) basis (e.g., Izard, 1971). Given both the diagnostic difficulties with social interaction and communication experienced by individuals with autism and the uniquely *inter*personal nature and origins of social emotions, it seems likely that this type of emotion will prove more difficult for people with autism to register in others or understand in themselves than other, non-social emotions.

In keeping with this suggestion, high-functioning individuals with autism (HFA), who do not have intellectual impairment (i.e., IQs > 70), appear relatively unimpaired in their ability to recognise expressions of non-social emotions in the faces of photographed actors (e.g., Heerey, Keltner, & Capps, 2003; Rutherford & Towns, 2008; van der Geest, Kemner, Verbaten, & Engeland, 2002; Wright et al., 2008; for alternative explanations and findings see e.g., Grossman, Klin, Carter, & Volkmar, 2000; Hobson, 1991; Wallace, Coleman, & Bailey, 2008). Amongst low-functioning individuals with autism (LFA), who do have accompanying learning disability (i.e., have IQs of 70 or below), there is greater evidence of deficits in the recognition of non-social emotions (e.g., Braverman et al., 1989; Hobson, 1982, 1986). However, even here differences between groups are observed usually when LFA participants are matched with non-autistic comparison participants only for *non-verbal* ability, and not when groups are matched for *verbal* skills (e.g., Ozonoff et al., 1990).

In keeping with the idea that difficulties in understanding social emotions should be particularly pronounced amongst people with autism, Heerey, Keltner and Capps (2003) found that even high-functioning children with autism were significantly less able than age- and verbal ability-matched comparison participants to identify expressions of embarrassment and shame in photographed actors. On the other hand, no group differences were observed in the recognition of non-social emotions, including 'complex', non-basic emotions such as surprise (contra Baron-Cohen, 1993).

In a similar vein, Losh and Capps (2006) found that high-functioning children with autism were as able as age- and verbal ability-matched comparison children to describe their previous experiences of non-social emotions (e.g., happiness, sadness, disappointment, surprise). However, when it came to describing their previous experiences of social emotions (pride, embarrassment, guilt, shame), participants with autism produced narratives that were significantly less contextually appropriate and coherent than those produced by comparison participants. These results replicate and extend those of Capps, Yirmiya, and Sigman (1992) who also found no qualitative differences between the self-reported experiences of happiness and sadness provided by children with and without autism, but found the descriptions of embarrassing situations provided by high-functioning children with autism significantly less appropriate than those provided by matched comparison participants.

Although this recent literature potentially provides a clearer picture of emotion-processing deficits in autism, other empirical evidence casts doubt even on the claim that individuals with autism show impaired comprehension of social emotions. Hillier and Allinson (2002), for example, presented relatively high-functioning individuals with autism (with mean verbal IQs of approximately 80), as well as age- and verbal ability-matched comparison participants, with a series of written scenarios involving potentially embarrassing situations. No significant differences between these two groups were observed in terms of either the overall degree of embarrassment attributed to the protagonist in each scenario, or in terms of the quality of explanation provided for these attributions.

More recently, Hobson et al. (2006) conducted a thorough investigation of social-emotion processing in low-functioning children with autism. Although in-depth parental interviews suggested that participants with autism manifested limited expression or understanding of social emotions in their everyday lives, participants' performance on experimental tasks provided little evidence that they did not grasp the nature of these emotions. Contrary to the authors' expectations, children with autism were as able as age- and verbal ability-matched comparison participants to (a) recognise expressions of pride, guilt, and shame/embarrassment in the videotaped (and photographed) expressions of actors; and (b) describe their own previous experiences of pride and guilt.

Although the sample sizes in the studies by Hillier and Allinson (2002), and Hobson et al. (2006) were relatively small (n = 10 per group and 12 per group, respectively), it is striking that even low-function children (in the latter study) did not display clear deficits in their recognition/understanding of social emotions. In their Monograph, Hobson et al. provide a thought-provoking discussion of the structure of social emotions, arguing that whilst typical individuals arrive at their understanding of such emotions through their experience of early interpersonal relations, individuals with autism may acquire their knowledge through an alternative, compensatory route (see below for further discussion).

The aim of the current investigation was to explore not only the extent to which children with autism grasp the nature of social emotions, but also to provide some preliminary evidence with regard to the basis of this understanding. If, as we agree with Hobson et al. (2006) is the case, social emotions are typically grounded in reciprocal social exchanges, and later conceptualised as such, then the ability to describe one's own experiences of social emotions should be significantly associated with the ability to recognise instances of such emotion-experience in others. Certainly, there is evidence from investigations of typical theory of mind development that the ability to recognise others' mental states is closely associated with the ability

to report mental states in self (e.g., Wellman, Cross, & Watson, 2001). However, if one's understanding of social emotions (or mental states) is only superficial, based on a kind of rule-bound cognitively-acquired heuristic (Hermelin & O'Connor, 1985), then there is no *a priori* reason to suppose that a close link between self- and other-understanding will exist (see Williams & Happé, in press; Williams, Lind, & Happé, in press). This may be the case amongst people with autism, if they possess only a cursory grasp of social emotions.

The current study was conducted in order to explore this set of issues. Following Losh and Capps' (2006) method, participants were asked to define and then describe previous experiences of social (pride, guilt, and embarrassment) and non-social (happiness, sadness, fear, surprise, disgust, and disappointment) emotions. Following this aspect of the study, participants were shown a series of standard video clips, each depicting an actor expressing one of these emotions. Participants were asked to identify the emotion expressed in each clip. It was predicted that participants with autism would be impaired in their capacity to report (in self) and recognise (in others) social emotions, but not non-social emotions. Amongst comparison participants, it was predicted that the ability to *describe* experiences of social emotions would be significantly associated with the ability to *recognise* social emotions. Amongst participants with autism, on the other hand, it was predicted that these abilities would not be significantly related, reflecting the use of task-specific strategies to complete the assessments, as opposed to typical conceptual competence.

Method

Participants

Ethical approval for this research was obtained from the appropriate Research Ethics Committee. Twenty-one children with autism spectrum disorder (ASD) and 21 comparison children completed the emotion recognition aspect of the experiment, after parents/guardians had given written, informed consent for their children to be included. The participants in the ASD group had received formal diagnoses, by a trained psychiatrist or pediatrician, of autistic disorder (n = 18), Asperger's disorder (n = 2) or atypical autism/pervasive developmental disorder not otherwise specified (PDD-NOS; n = 1) according to established criteria (American Psychiatric Association, 2000). All participants in this group attended specialist autism schools, which required a diagnosis of autism, Asperger's syndrome or PDD-NOS for entry into the school. The comparison group consisted of children with general learning disability of unknown origin who attended schools for children with developmental disabilities/special educational needs.

Background Assessments

Baseline verbal and non-verbal abilities were assessed using an appropriate measure for the developmental level of each participant. The verbal abilities of 15/21 children with ASD and 15/21 comparison children were assessed using the Vocabulary and Information subtests of the Wechsler Intelligence Scale for Children – Third Edition (WISC-III; Wechsler, 1991). The verbal IQ estimate gained from this short form has high reliability (Sattler, 1992). Because the lowest test age-equivalent offered by the WISC-III is 6 years 2 months, the verbal mental age (VMA) of any participant who fell below this level on either of the verbal subtests could not be calculated. Under

these circumstances, participants were administered the British Picture Vocabulary Scale – Second Edition (BPVS; Dunn et al., 1997), which offers test age-equivalents down to 2 years 11 months. The verbal abilities of 6/21 children with ASD and 6/21 comparison children were assessed with the BPVS.

The non-verbal abilities of all participants were assessed using the Block Design and Picture Completion subtests of the WISC-III. Due to limited child availability, the non-verbal abilities of one participant with ASD and one comparison participant were not assessed[1]. Participant characteristics for the total sample of ASD and comparison participants are presented in Table 1.

Table 1 here

Given that some ASD and comparison participants received the Wechsler Scales (Wechsler, 1991), whilst others received the BPVS (Dunn et al., 1997), independent *t*-tests were conducted comparing ASD and comparison participants from each sub-sample to ensure adequacy of matching in each case, as well as overall. ASD and comparison participants who received the WISC-III were well matched on all variables (all *t*s < 0.40, all *p*s > .69), as were ASD and comparison participants who received the BPVS (all *t*s < 0.53, all *p*s > .61).

Three children with ASD did not have data for the emotion reporting aspect of the experiment. The remaining groups (of 18 children with ASD and 21 comparison participants) were still well matched for this aspect of the study (all *t*s < - 0.71, all *p*s > .48).

Design and Procedures

All participants were given the emotion reporting task first, followed by the emotion recognition task.

Reporting emotion experiences in self

Participants were asked two questions about each emotion, in a fixed order. Firstly, participants were asked to *define* the emotion in question (e.g., "What does 'proud' mean?") and their response was noted by the experimenter. Regardless of the quality of the participant's definition, the experimenter always subsequently offered a standard definition, based on situations in which people would typically experience the emotion. For the emotion 'pride', for example, the experimenter would say, 'Well, I think people feel proud when they have done something really well, much better than they or other people thought they would do'. The definitions offered by participants for each emotion were rated as either correct or incorrect. For example, a correct definition of 'pride' had to contain reference to 'some positive act under the control of the individual which was either explicitly or implicitly relative to some standard'.

Having defined the emotion in question, the participant was then asked to *report* a time in their lives when they had experienced the emotion. Their report was noted, verbatim, by the experimenter. The types of emotion were presented in the following fixed order with social and non-social emotions interspersed: sadness, pride, disappointment, fear, embarrassment, surprise, happiness, guilt and disgust.

Following previous studies of emotion processing amongst typically and atypically developing children (e.g., Capps et al., 1992; Losh & Capps, 2006), self-reported experiences of each emotion were rated for the degree to which they involved contextually suitable situations. Each report was rated on a scale of 0 to 2. A score of 2 was assigned to reports that unambiguously described situations which were appropriate for eliciting the emotion in question (e.g., "I felt proud when I won the 100 metres race at school"; "I felt embarrassed when I fell over and everyone laughed at me"). A score of 1 was assigned to reports that described events which would not typically elicit the emotion in question, but which might usually elicit a feeling with a similar hedonic tone (e.g., "I felt disappointed when my grandma died"). Finally, a score of zero was assigned to reports that described events which would not have elicited the emotion in question (e.g., "I felt disgusted when I went to the park and played on the swings"; "I felt guilty when I did my homework"), or when participants offered no response.

The first author of this paper rated each transcript in the first instance. A second rater, who was blind to participant diagnoses and the hypotheses of the study, independently rated 6/39 (15%) transcripts. Inter-rater reliability was high for both the correctness of emotion definitions ($\kappa = .76$) and the quality of emotion reports ($\kappa = .80$) (see Cohen, 1992).

Recognition of emotions in others.

Stimuli for the recognition task were nine silent, five-second video clips each of an actor expressing a different emotion. Stimuli were taken from 'Mind Reading: An Interactive Guide to Emotions' (Baron-Cohen, 2004), which provides standard expressions of each of the emotions. Participants watched the nine clips in turn and, after each, stated what emotion they believed was expressed by the actor.

Given concerns about forced-choice response methods (Haidt & Keltner, 1999), and following Heerey et al. (2003), a partly-free response method was adopted such that children could either spontaneously generate a word to describe the emotion expressed by each actor, or choose a word from a list of six emotion terms. A different list was provided for each of the nine emotions, and each list consisted of the target emotion plus five distractor emotion terms from the study.

Before beginning the task, it was established that the participant could read each of the emotion words. Four participants (two with ASD and two comparison participants, each with a VMA under 6 years) were unable to read the words on the list. For these participants, the experimenter read out each of the six words on each list after the video clip had been viewed.

Each clip was presented in the bottom left-hand corner of a standard laptop in a window approximately 10 × 10 cm in size. Each accompanying list of words was presented on-screen in Times New Roman font, 20 point, alongside the clip. Clips were presented in the following fixed order: happiness, guilt, surprise, sadness, pride, disgust, fear, embarrassment, and disappointment.

Results

Reporting Emotion Experiences in Self

Firstly, a series of chi-square analyses was conducted to compare the number of participants from each diagnostic group correctly *defining* each of the nine emotions.

These analyses yielded no significant differences between the groups (all χ^2s < 1.82, all *p*s > .24). Both groups of participants appeared quite proficient at spontaneously defining each emotion. Figure 1 shows the percentage of participants from each diagnostic group correctly defining each emotion.

Figure 1 here

Next, points were tallied for participants' *reports* of each type of emotion experience, yielding scores of 0-12 for the six non-social emotions and 0-6 for the three social emotions. Because each type of emotion contained a different number of exemplars, overall percentage scores were calculated for each type of emotion for the purpose of comparison. Table 2 shows the mean percentage scores awarded for reports of social and non-social emotion experiences amongst ASD and comparison participants.

Data were analysed using a 2 × 2 repeated-measures ANOVA, with diagnostic group (ASD/comparison) as the between-participants factor and emotion-type (social/non-social) as the within-participants variable. This ANOVA yielded a significant main effect of condition, reflecting the fact that participants' reports of non-social emotions were significantly superior to their descriptions of social emotions, $F(1, 37) = 26.82$, $p < .001$, $r = .65$. The main effect of diagnostic group was not significant, indicating that, overall, the reports of emotion experiences offered by participants with ASD were not significantly different in quality from those offered by comparison participants, $F(1, 37) = 0.99$, $p = .76$, $r = .16$. There was no significant interaction between emotion-type and diagnostic group, indicating that participants with ASD showed the same pattern of performance across emotion-types as comparison participants, $F(1, 37) = 2.67$, $p = .11$, $r = .26$.

Table 2 here

Finally, a series of Mann-Whitney tests was conducted, comparing the quality of self-reports (on a scale of 0 to 2 points) of each emotion, independently, amongst ASD and comparison participants. These analyses revealed that participants with ASD described their own feelings of disappointment significantly less well than comparison participants, $U = 107.00$, $p = .007$, $r = .44$. However, this post hoc comparison did not remain significant after a Bonferroni correction for multiple comparisons had been applied. No other differences were significant (all *U*s > 155.00, all *p*s > .34). Figure 2 shows the mean score for each of the nine reports of emotion experiences, by ASD and comparison participants. Also, a representative set of participants' self-reports of social emotions is included in Appendix 1. This serves to illustrate how similar the descriptions offered by ASD and comparison participants were, and how difficult it would be to distinguish the two groups on the basis of emotion reports.

Figure 2 here

Relationship between VMA and quality of self-reports

Amongst comparison participants, VMA was not significantly associated with the quality of reports of social ($r = .19$, $p = .42$) or non-social ($r = .15$, $p = .51$) emotion experiences. In contrast, amongst participants with ASD, VMA was significantly

correlated with reports of both social (r = .66, p = .003) and non-social (r = .65, p = .004) emotion experiences.

Recognition of Emotion in Others

One point was given for each emotion correctly identified and then points were tallied for each type of emotion, yielding scores of 0-6 for non-social emotions and 0-3 for social emotions. Again, for the purposes of comparison, percentage scores were calculated for each type of emotion. Table 3 shows the percentage of social and non-social emotions correctly recognised by ASD and comparison participants.

Table 3 here

Data were analysed using a 2 × 2 repeated-measures ANOVA, with diagnostic group (ASD/comparison) as the between-participants factor and emotion type (social/non-social) as the within-participants variable. This ANOVA yielded a significant main effect of condition, reflecting the fact that participants recognised non-social emotions significantly more reliably than they recognised social emotions, $F(1, 40) = 86.66$, $p < .001$, r = .83. The main effect of diagnostic group was not significant, indicating that, overall, participants with ASD showed the same level of recognition as comparison participants, $F(1, 40) = 0.21$, p = .65, r = .07. The interaction between condition and diagnostic group was not significant indicating that participants with ASD showed the same pattern of recognition performance, across emotion-types, as comparison participants, $F(1, 40) = 0.72$, p = .40, r = .13.

Finally, a series of chi-square analyses did not reveal significant differences in the numbers of participants from each diagnostic group correctly recognising each of the nine emotions, individually, all χ^2s < 4.29, all ps > .10. Figure 3 shows the percentage of ASD and comparison participants correctly recognising each emotion.

Figure 3 here

Relationship between VMA and emotion recognition

Amongst participants with ASD, VMA was not significantly related to the recognition of social or non-social emotions, all rs < .12, all ps > .62. Amongst comparison participants, VMA was significantly correlated with the ability to recognise non-social emotions, r = .56, p = .008, but not social emotions, r = .32, p = .16.

Relation Between Describing Emotions in Self and Recognising Them in Others

A series of partial correlation analyses, controlling for chronological age and VMA, was performed in order to assess the relationship between reporting emotions in self and recognising them in others. Given that there were no between-group differences in the ability to report emotion experiences, or to recognise emotions in others, the groups were collapsed, in the first instance, to increase the power of the analysis.

When both diagnostic groups were collapsed, only the following partial correlations were significant (all other ps > .12): recognising social emotions × reporting social emotions (r = .46, p = .004), and recognising non-social emotions × reporting non-social emotions (r = .37, p = .03). However, only the correlation between recognising social emotions in others and reporting social emotions in self

remained significant after Bonferroni adjustments for multiple comparisons had been applied.

When partial correlations were performed within each group separately, the correlation between recognising social emotions in others and describing social emotions in self was significant amongst both participants with ASD (r = .70, p = .003) and comparison participants (r = .47, p = .04). The significant positive correlation between recognising social emotions in others and describing social emotions in self was not predicted amongst participants with ASD. However, this correlation remained significant even after adjusting for multiple comparisons.

Discussion

The results of this study were remarkably clear, although somewhat contrary to our hypotheses. Most importantly, children with autism (with average verbal IQs of just above 70 and average performance IQs of just under 70) were as able as age- and ability-matched comparison participants to recognise 'social' and 'non-social' emotions in others, and to describe their own previous experiences of these emotions. Although equivalent levels of performance between the groups were expected with regard to the recognition/reoprting of non-social emotions, such similar levels of understanding of social emotions between the groups were not predicted.

Although this result runs counter to those of some previous studies (Capps et al., 1992; Heerey et al., 2003; Losh & Capps, 2006), it is important to note that this is not the first study to find children with autism unimpaired at recognising/reporting social emotions. For instance, our results closely match those of Hobson et al. (2006), who explored social emotion understanding amongst low-functioning children with autism, and Hillier and Allinson (2002) who explored understanding of embarrassment amongst high-functioning children.

On the one hand, it is possible that the lack of between-group differences observed in the current study was due to the use of a potentially insensitive methodology, which failed to detect (perhaps subtle) deficits amongst participants with autism. On the other hand, in neither the emotion recognition nor emotion description aspects of the study did participants display ceiling levels of performance. As such, the tasks were not merely too simple for participants.

Another possible reason why group differences in emotion processing abilities were not observed in the current study might be due to the characteristics of the participant samples employed. Perhaps deficits in emotion processing are clearer in younger and/or less able individuals with autism than employed in the current study. However, the fact that some studies *have* found emotion processing deficits in older and more able individuals with autism than participants in this study (e.g., Losh & Capps, 2006), whereas other studies have *failed* to find deficits in younger/less able children (e.g., Hobson et al., 2006), suggests that the age/ability-level of the participants is not the critical factor in determining whether statistically significant group differences are observed.

As noted above, it is surprising how inconsistent the findings of experimental studies of emotion processing in autism have been. As Hobson et al. (2006, p.37) note, this surprise is mainly "because there is a perplexing gap between what children [with autism] show in their daily lives, and what they seem able to formulate in words". A possibility raised by several researchers (e.g., Hermelin & O'Connor, 1985), including Hobson et al., is that affected children's understanding of emotions, as it is tapped by experimental measures, is only superficial, and that successful

performance on such measures is the result of compensatory (possibly task-specific) strategies. Some studies have found evidence which suggests that performance on emotion recognition tasks is uniquely supported by verbal intelligence amongst individuals with autism (e.g., Grossman et al., 2000). In the current study, however, verbal IQ was not significantly associated with the ability to recognise either social or non-social emotions amongst participants with autism (although verbal IQ was uniquely related to the ability to *describe* previous emotion experiences amongst these participants).

Perhaps more suggestive that task-specific, compensatory strategies were *not* being used by participants with ASD in the current study was the finding that amongst both groups of participants there was a significant (and substantial) correlation between the ability to recognise social emotions in others and describe experiences of one's own social emotions. Whatever underlying cognitive process was responsible for successful recognition of these emotions was apparently also responsible for the ability to understand these emotions in self. It has been argued from philosophical (e.g., Strawson, 1962) and psychological (e.g., Hobson, 1990) perspectives that concepts of self, including one's own emotions, and others are fundamentally intertwined. The positive correlations between recognising and describing social emotions may, therefore, suggest that underlying concepts of these emotions, rather than compensatory strategies, are driving successful task performance amongst both participant groups. On the other hand, it is possible that amongst one or both groups this significant correlation was the result of the *same* compensatory strategy being employed to mediate both experimental tasks. Whilst this possibility cannot be entirely ruled out, the current results do not provide any support for the suggestion that *task-specific* strategies are used by children with ASD to mediate emotion processing tasks.

Footnotes

To ensure that the groups would still be matched for performance IQ we arbitrarily assigned the outstanding ASD participant with the maximum possible performance IQ score (140 points) and the outstanding comparison participant with the minimum possible performance IQ score (45 points). A re-analysis of the data confirmed that the groups would still have been well matched under these conditions, $t(40) = 0.75$, $p = .46$, $r = .12$.

Appendix 1

Pride

2 point descriptions:
"…I sang a song very well at a disco and everybody cheered and I felt proud" (ASD participant; CA = 12.42, VMA = 10.83).
"When I won a shield for the Governor's award for improved behaviour" (comparison participant; CA = 12.00, VMA = 10.33).

1 point descriptions:
"When I ride on big bikes" (ASD participant; CA = 7.42, VMA = 4.33)
"When I did my merits properly" (comparison participant; CA = 14.00, VMA = 6.58).

0 point descriptions:
"When I got a DVD" (ASD participant, CA = 12.42; VMA = 6.67).
"When my Dad let me watch this film without asking" (comparison participant; CA = 10.42, VMA = 6.42).

Embarrassment

2 point descriptions:
"When I was going home from school I accidentally spilled some water on my trousers and people saw it and they laughed at me and they asked if I'd wet myself" (ASD participant; CA = 15.75, VMA = 11.83).
"When I first came to this school and when I've been on stage acting in assemblies" (comparison participant; CA = 12.00, VMA = 10.33).

1 point descriptions:
"I did something silly. I forgot to do my homework" (ASD participant; CA = 9.08, VMA = 7.83).
"I was outside playing and then someone came up to me and they said 'hey what you doing?'" (comparison participant; CA = 10.42, VMA = 6.67).

0 point descriptions:
"I jump up and down" (ASD participant; CA = 12.08, VMA = 8.00).
"I've been embarrassed of my brother when I ask him to buy us something and he says 'no'" (comparison participant; CA = 8.42, VMA = 5.17).

Guilt

2 point descriptions:
"When I done something bad yesterday – I bit my Mum" (ASD participant; CA = 12.08, VMA = 8.00).
"When I told my friend she could stay, but I let somebody else stay" (comparison participant; CA = 14.32, VMA = 7.50).

1 point descriptions:
(all participants with ASD scored either 0 or 2 points)

"When I was little and I was grounded" (comparison participant; CA = 14.25, VMA = 9.33).

0 point descriptions:
"No, I'm not guilty" (ASD participant; CA = 13.08, VMA = 6.67).
"When I couldn't do the work in school" (comparison participant; CA = 12.42, VMA = 6.83).

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Table 1: Participant characteristics: Means and (standard deviations)

	ASD	Comparison	*t*	*p*	Effect size (*r*)
n	21	21			
CA: years	12.35 (2.26)	12.59 (1.94)	-0.37	.72	.06
VMA: years	8.42 (2.24)	8.31 (1.97)	0.17	.87	.03
VIQ	73.24 (13.77)	69.33 (11.26)	1.01	.32	.16
PIQ[a]	67.10 (18.63)	66.60 (18.68)	0.85	.93	.14

a Based on data from $n = 20$ participants with ASD and $n = 20$ comparison participants.

Table 2: Mean (SD) percentage scores for reports of social and non-social emotion experiences by ASD and comparison participants.

	Emotion type	
Group	Non-social	Social
ASD (n = 18)	69.91 (25.10)	54.63 (35.15)
Comparison (n = 21)	79.37 (13.84)	50.00 (31.62)

Table 3: Mean (SD) percentage of non-social and social emotions correctly recognised by ASD and comparison participants.

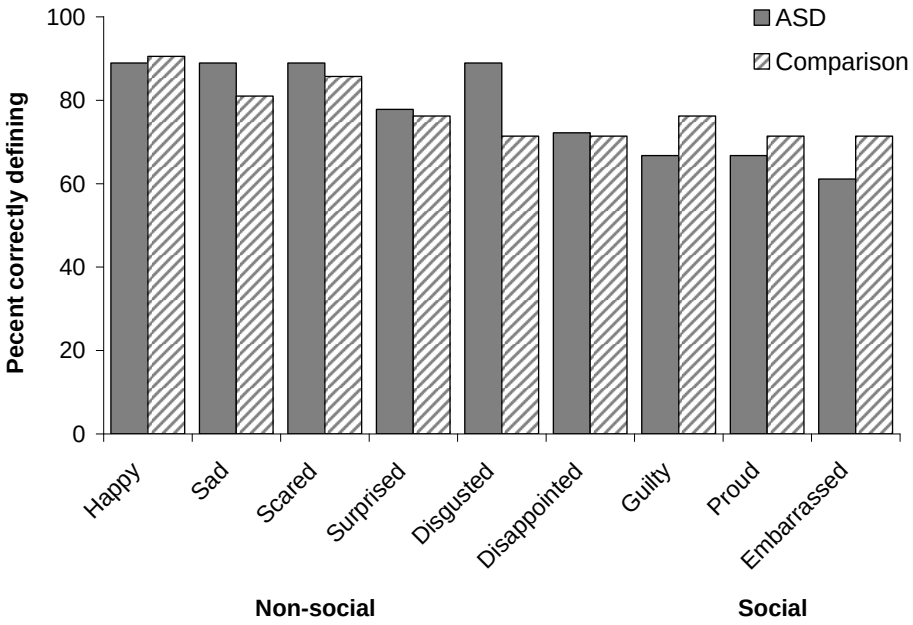
	Emotion type	
Group	Non-social	Social
ASD (n = 18)	76.98 (23.85)	41.27 (29.64)
Comparison (n = 21)	77.78 (18.51)	34.92 (22.30)

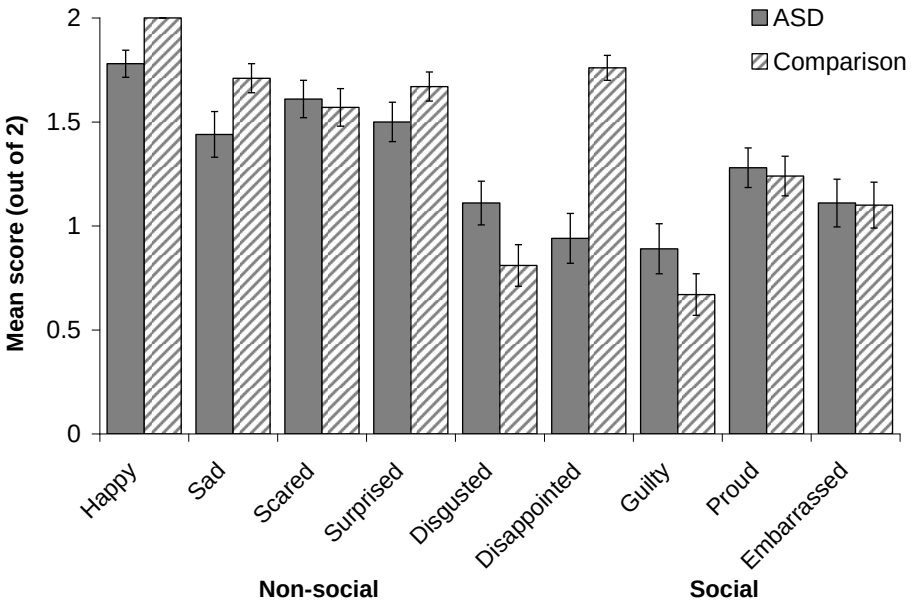
Figure Captions

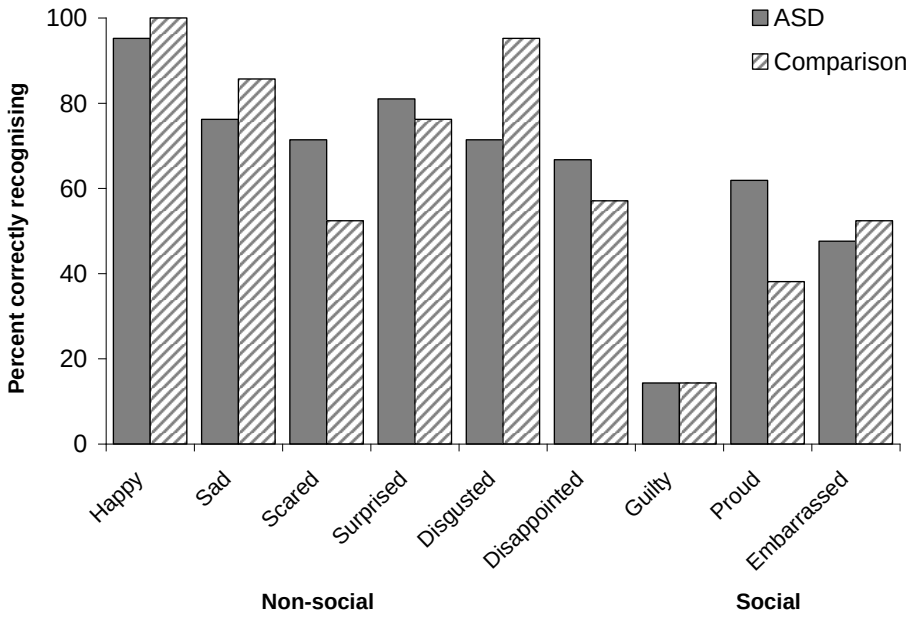
Figure 1: Percentage of ASD and comparison participants correctly defining each emotion.

Figure 2: Mean scores (out of 2) for each of the nine emotion descriptions by ASD and comparison participants. Error bars represent one *SE* of the mean.

Figure 3: Percentage of ASD and comparison participants correctly recognising each emotion.


ASD
Comparison
Pecent correctly defining
100
80
60
40
20
0
Happy
Sad
Scared
Surprised
Disgusted
Disappointed
Guilty
Proud
Embarrassed
Non-social
Social


ASD
Comparison
Mean score (out of 2)
2
1.5
1
0.5
0
Happy
Sad
Scared
Surprised
Disgusted
Disappointed
Guilty
Proud
Embarrassed
Non-social
Social


ASD
Comparison
Percent correctly recognising
100
80
60
40
20
0
Happy
Sad
Scared
Surprised
Disgusted
Disappointed
Guilty
Proud
Embarrassed
Non-social
Social