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Attention to facial emotion expressions in children with autism

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ABSTRACT High-functioning children in the autism spectrum are frequently noted for their impaired attention to facial expressions of emotions. In this study, we examined whether attention to emotion cues in others could be enhanced in children with autism, by varying the relevance of children's attention to emotion expressions. Twenty-eight high-functioning boys with autism and 31 boys from a control group were asked to sort photos depicting smiling or frowning faces of adults. As found in earlier studies, in neutral conditions children with autism were less attentive to emotion expressions than children from a control group. This difference disappeared when children were explicitly asked to make a socially relevant decision. These findings suggest that the attention of children with autism to emotion expressions in others is influenced by situational factors. Theoretical implications of these findings are discussed.

KEYWORDS *emotions; facial expressions; high-functioning autism; PDD-NOS*

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Reading others' emotional expressions is essential to social interactions, because this information helps to explain and anticipate other people's actions. Processing facial information is likely to be one of the earliest facilitators of social engagements (Bushnell et al., 1989). According to Darwin (1872), the recognition and understanding of basic emotional expressions is an innate ability. Studies have indicated that, in normal development, even very young infants spontaneously attend and discriminatively react to emotional expressions in others. For example, neonates

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show recognition of qualitative differences in facial emotional expressions and 10-week-old babies react appropriately to distinct expressions (Caron et al., 1982; Izard, 1994; Klinnert et al., 1983). Although it is hard to establish to what extent such young babies fully understand these signals (Harris, 1989), these findings nevertheless imply that the processing of facial information is one of the earliest means of social involvement.

In contrast to other mental processes, emotions are often visible in facial expressions. As soon as children acknowledge that facial expressions tend to reveal something about people's inner states, attending to those expressions may become a stepping-stone for the development of more general 'mind reading' (Baron-Cohen, 1995). This refers to the ability to attribute mental states (i.e. *desires*, which refer to wishes, hopes and needs, and *beliefs*, which refer to thoughts, expectations, convictions and ideas) to other people. Children who do not spontaneously attend to emotional expressions in others will often miss information that can be crucial to infer others' desires and beliefs, which in turn will hamper their understanding of other people's actions. Insight into other people's mental states is thought to emerge around 2 or 3 years of age, when children show pretence or imagine psychological states (Harris, 1989). Mind reading stresses the importance of emotional information and thereby stimulates attention to emotional expressions even further (Hobson, 2002).

Due to their key role in social interactions, deficits in the perception of emotions have long been thought – at least partially – to account for the social disabilities that can be observed in children with autism spectrum disorders. Kanner (1943) originally described the autistic condition as insensitivity towards emotional expressiveness of others. Reduced attention to facial expressions of emotions in participants with autism has been found in various studies, in which participants were asked to sort or match emotion or non-emotion photographs (Celani et al., 1999; Tantam et al., 1989), or pair different modes of emotional expressions (Hobson, 1986; Hobson et al., 1988). However, several other studies failed to find evidence for impaired attention to emotions, in particular when the participants with and without autism were matched on verbal intelligence (e.g. Braverman et al., 1989; Ozonoff et al., 1990; Prior et al., 1990).

Generally, high-functioning children with autism seem to do well on emotion recognition concerning the basic emotions of happiness, anger, sadness and fear (Davies et al., 1994; Loveland et al., 1997), but have difficulties when tasks involve more complex emotions, such as surprise (Baron-Cohen et al., 1993), pride (Kasari et al., 1993), shame or embarrassment (Capps et al., 1992; Heerey et al., 2003) and jealousy (Bauminger, 2004). Moreover, when normally intelligent children with autism were compared with mental age matched controls, attention deficits were found when the

complexity of the tasks was increased. For example, presenting only the eye region of facial expressions, or combining expressions with mismatching emotion words, led to poorer performances in children with autism (Baron-Cohen et al., 1997; Grossmann et al., 2000).

Jennings (1974) used a different approach to investigate emotion attention in low-functioning individuals with autism. Participants were asked to categorize photographed human faces, which differed on both non-emotion (e.g. hats) and emotion (facial expressions) features. The children with autism categorized the faces more often on non-emotion features than the control children. Elaborating on this experiment, Weeks and Hobson (1987) varied not only the emotion but also the identity of the depicted people, in order to test for emotion attention over different individual facial structures. A similar preference for non-emotion features was found in the majority of children with autism. However, both studies also showed that these low-functioning participants with autism could sort on the basis of emotion features when they were explicitly asked to do so. An important conclusion that can be drawn from these findings is that, although they might not give the same priority to facial expressions as typically developing children, even in low-functioning children with autism the ability to perceive emotional expressions seems to be essentially intact.

The question then is why, in these studies, children with autism used this skill less than their typically developing peers. Possibly, the direct relevance of facial emotional expressions played a role in those settings. Participants usually construe their own reasons for focusing on certain aspects of a task and comply with their expectations of the task's demands (Orne, 1969). The natural priority that is given to facial expressions by typically developing children might stem from their acknowledgement that emotional information is pertinent – or at least could become pertinent in the near future – under almost all circumstances. Yet, participants in these studies are not dealing with real people, nor are there usually any references to future interactions. Therefore, a finding that children with autism tend to ignore emotional expressions under these artificial circumstances might indicate that they fail to apply their ability to read emotional expressions in situations in which the value of such information is not immediately manifest. Consequently, the results of the studies discussed may provide data on children's baseline attention to emotional expressions, but they do not necessarily imply that children with autism fail to exhibit attention to others' emotions when situations directly require it – much less that they are unable to attend to others' emotions.

Other studies have also found that external 'triggers' can activate latent abilities in children from the autism spectrum. Task performance of children with autism, known for their low task motivation (Koegel and Mentis,

1985), was enhanced when their task involvement increased. Children's performances improved, for example, when they were prompted by explicit instructions, when their active task participation was reinforced, or when their personal interest increased (Begeer et al., 2003; Dunlap, 1984; Lewis and Boucher, 1988; O'Dell et al., 1983; Rieffe et al., 2000; Volden et al., 1997). Therefore, the absence of social relevance in laboratory studies using the traditional sorting method might cause a relative underestimation of the ability to attend to emotion cues by children with autism. In this study, in which we focus on high-functioning children with an autism spectrum disorder, we examine (1) whether the frequently noted lack of spontaneous attention to facial expressions can also be found within this high-functioning subgroup, and (2) whether their attention to emotional information improves when the situation contains some elements that may prime the relevance of such information.

The current study included high-functioning (IQ > 80) children from the autism spectrum and typically developing control children, and aimed to compare children's attention to emotions in a 'neutral' setting in which the temporary feeling state of others did not have direct implications, and in a setting where emotional information could have direct implications for their own wellbeing. In both conditions, a sorting task was used, similar to the experiment with low-functioning children with autism conducted by Weeks and Hobson (1987). Children were presented with photographs of people who differed according to their facial expression of emotions (positive or negative), and two non-emotional features: moustaches and glasses (present or absent). In the neutral condition, children were asked, without any further explanation, to select pairs of photographs that were 'most similar'. In the primed condition, children were asked to pair the photos based on their expectations of the people's future actions. The likelihood of these actions could easily be linked to basic action tendencies that were part of the expressed emotions (e.g. people with positive emotional expressions tend to be generous; people with negative emotional expressions are more likely to punish you). Moreover, the actions that children were asked about involved their own interests, because they were asked to group the two people that they thought would act positively or negatively towards them. This element of personal relevance was expected to prompt their engagement and increase their task motivation. Therefore, it was expected that the high-functioning children with autism in this study would be less attentive to facial emotional expressions than their typically developing peers in the neutral condition, but that children from both groups would show an equal interest in emotional expressions in the primed condition.

Method

Participants

Three groups of participants (all boys) were tested, two groups from the autism spectrum and a control group. The first group included 11 boys with classic autism (mean age 9:9, range 7:4 to 12:9), the second group included 17 boys with PDD-NOS (mean age 9:1, range 7:3 to 11:9) and the typically developing control group included 31 boys (mean age 9:6, range 8:0 to 10:7). The children with autism and PDD-NOS were recruited from a specialized child psychiatric centre providing both inpatient and outpatient care for children with disorders in the autism spectrum. A control group was recruited from two primary schools around Amsterdam, The Netherlands.

The diagnostic classification of the children from the autism spectrum was based on a 3 month diagnostic assessment by a child psychiatrist, during which multiple informants, psychologists and educationalists, also observed and tested the children in the group and in school. The children with high-functioning autism showed a history of 'classical' autism and fulfilled established diagnostic criteria according to the DSM-IV. Children were classified as PDD-NOS when they met three or more criteria for autistic disorder according to the DSM-IV, and when their impairments had an onset before the age of 36 months, but the full set of criteria of an autistic disorder were not met (American Psychiatric Association, 1994). The verbal (mean 99.8, SD 16.0) and non-verbal IQ (mean 94.4, SD 17.3) of the children were within the 'normal' range, based on the Wechsler Intelligence Scale for Children–III (Wechsler, 1991) or the RAKIT intelligence test (Bleichrodt et al., 1993). The autism subgroups of children with PDD-NOS and autism did not differ on verbal and non-verbal IQ. The typically developing control group was not explicitly tested for their intelligence. However, they functioned at an adequate level in regular elementary schools, and according to their teachers they showed intelligence within the 'normal' range.

Materials

The experiment consisted of four trials, two trials per condition (neutral and primed). During each trial, using a laptop computer, children were presented with combinations of four black-and-white photographs showing male faces. The neutral condition consisted of the first two trials, whereas the primed condition consisted of the last two trials.

After an introduction to make them familiar with the sorting procedure (see 'Procedure'), children were instructed as follows: 'That went very well. Now we will do a very similar game. I'll show you pictures of four people.

These pictures are different in some ways, and the same in other ways, just like the previous task. You may choose again which two of the four pictures are most similar according to you.' This was repeated in the second trial with another set of photos.

In the third trial, the positive primed condition, children were instructed as follows: 'Now, I will show you four pictures again. But this time I want to ask you something different. Which two would be most likely to give you a sweet?' In the fourth trial, the negative primed condition, children were asked: 'Imagine all of the men in the pictures are teachers. Which two teachers are most likely to tell you off?'

The photograph combinations were randomly chosen from a database containing a total of 49 photos of 16 different individuals. Each child was presented with random photo combinations of four different individuals. For each presentation, the photos were arranged in such a way that any categorization of two photos would correspond to one of three possible selection features: glasses (present or absent), moustache (present or absent) and valence of emotional expression (happy or angry). The common feature of the two photos chosen by the subject in the first presentation (e.g. a subject chooses two faces with glasses) was subsequently entered in the computer by the experimenter. The computer then automatically created a second random combination of four different photos that were equal on the feature selected after the first presentation (i.e. no one wore glasses this time). After this combination was displayed in a second presentation, again two photos could be paired based on one of the two remaining features (i.e. moustache and emotional expression). Each trial included two presentations and the total amount of presentations was eight. The computer program was written for the purpose of this experiment.

The photos were taken from the Yale Faces database (Belhumeur et al., 1997). Weeks and Hobson (1987) reported interpretive problems due to a high salience of a non-emotion feature (gender). To ensure an equal distribution of salience among the selection features in the present experiment, we conducted a pilot study among college students ($n = 15$) in which the salience of selection features was judged for different combinations of four photographs. The combinations that evoked equal distributions of common features in the selected pairs (i.e. moustache, glasses and emotional expression were chosen as selection criteria with equal frequency) were used in the actual experiment.

Procedure

A male experimenter tested the participants individually for about 15 minutes. First of all, a training task was presented, designed to illustrate the principle of the actual task. Four geometric figures were shown, which

differed on three features: shape (square/rectangle), colour (grey/black) and size (big/small). Participants were asked to select two figures that were most similar according to them, in the following way: 'We'll play a game now. I will show you four pictures of figures. All you have to do is tell me which two pictures are most similar according to you.' Children had two opportunities to select pairs of figures. When children paired two figures containing feature X, indicating their first preference for that feature, the next presentation of figures would consist of four figures varying only with respect to the remaining two features. Children were asked again to select two similar figures. The next pair that was selected revealed children's second preference among the three features, as well as their least preferred feature. During this training, participants did not need to verbalize which features the pairs had in common. This training procedure was practised twice. The actual experiment followed the exact same procedure, but photographs of faces replaced the geometric figures.

Following the scoring system designed by Weeks and Hobson (1987), children received a score of 2 when they selected two faces with similar emotional expressions during the first presentation of three selection features (direct emotion selection). A choice of faces with similar emotional expressions during the second presentation with two criteria to choose from was scored 1. Children who gave no priority to emotional expressions at all were scored 0 (no emotion selection). Children's scores over two trials for each condition could thus vary from 0 to 4.

Results

All children understood the sorting procedure of the geometric figures on different features in the introductory task and were admitted to participate in the second part of the study. Table 1 shows the frequencies of children's emotion selections as a function of group (autism and control) and condition (neutral and primed).

A clear majority of the children with autism and nearly half of the control group never sorted the photographs they were presented with on the basis of the emotional expression in the first two trials. Children with autism sorted the photos less often on the basis of the emotion expressions than children from the control group in the neutral condition. A non-parametric Mann–Whitney *U*-test confirmed this finding ($U = 328.5$, $p < 0.05$, one-tailed).

The primed condition evoked more attention to emotional expressions in both groups and all children sorted the photos at least once on their emotional expression. As predicted, no group difference was found in this primed condition. Children with autism showed attention to the facial

Table 1 **Frequency of responses in which emotion was used as selection criterion as a function of group (autism and control) and condition**

	Emotion priority in selection				
	4	*3*	*2*	*1*	*0*
*Neutral condition**					
Autism group (*n* = 28)	2 (7%)	1 (3%)	3 (11%)	3 (11%)	19 (68%)
Control group (*n* = 31)	4 (13%)	4 (13%)	4 (13%)	5 (16%)	14 (45%)
Primed condition					
Autism group (*n* = 28)	16 (57%)	6 (22%)	4 (14%)	2 (7%)	0 (0%)
Control group (*n* = 31)	22 (71%)	4 (13%)	3 (10%)	2 (6%)	0 (0%)

*Between-group difference, $p < 0.05$.
Scores: 4 = emotion selection after first presentation of both trials, 3 = emotion selection after first presentation of one trial and second presentation of other trial, 2 = emotion selection after first presentation of one trial or after second presentations of both trails, 1 = emotion selection after second presentation of one trial, 0 = no emotion selection.

emotional expressions of the people in the photos as frequently as children from the control group ($U = 378.0$, $p = 0.16$, one-tailed). Children's attention to positive or negative emotional expressions was also analysed separately. No group differences were found in attention to positive (happy) ($U = 411.0$, n.s.) or negative (angry) ($U = 354.5$, n.s.) emotions of children with autism and typically developing children.

These results indicate that the explicit addition of social relevance to the instructions resulted in equivalent performances between the clinical and the non-clinical groups. However, based on Table 1 it is unclear whether the priming condition led to similar incremental or discrete increases in preference scores for all children. Therefore, we calculated increment scores between the neutral and primed conditions for each child. The frequency of increment scores in Table 2 shows that approximately one-third of the children in both groups did not select on emotion

Table 2 **Frequency of increase in emotion selection between neutral and primed condition as a function of group**

	Increase in emotion priority in selection					
	–1	*0*	*1*	*2*	*3*	*4*
Autism group (*n* = 28)	0 (0%)	2 (7%)	4 (14%)	7 (25%)	6 (21%)	9 (32%)
Control group (*n* = 31)	2 (7%)	5 (16%)	4 (13%)	6 (19%)	3 (10%)	11 (36%)

in the neutral condition, but immediately did so in a primed condition (increment is 4). Almost one-quarter (23 percent) of control children did not show any increment or even showed a decrease.

The results in Table 1 do not reveal the different ways in which a child could receive a score of 2 or 3. For instance, a score of 2 was given for selecting on emotion expressions after one first presentation, but also for selecting on emotion after two second presentations. As can be seen in Table 3, the number of direct, indirect and absent emotion selections of children with autism and controls are relatively similar in the primed condition, but differ in the neutral condition. Children with autism more often than the controls failed to select on emotion alone in the neutral condition ($U = 328.5$, $p < 0.05$, one-tailed). None of the other frequencies of emotion selections differed between groups.

Besides differences in attention to emotional features, we predicted a higher degree of salience for the moustaches than the glasses in the autism group. Earlier studies have shown that high-functioning children with autism recognize facial information from the mouth regions better than information from the eye regions (Joseph and Tanaka, 2003; Langdell, 1978). However, in the present experiment, no group differences were found in preferential patterns for eye regions (i.e. glasses, $U = 365.5$, $p = 0.27$) or mouth regions (i.e. moustaches, $U = 432.5$, $p = 0.98$).

Although no explicit hypotheses were formulated with respect to the subgroups within the autism spectrum, an extra analysis was carried out in order to explore possible differences between children with autism ($n = 11$) and PDD-NOS ($n = 17$). No differences were found in either the neutral or the primed condition (see Table 4).

Finally, in order to control for a possible relationship between the attention to facial emotional expressions and intelligence levels, we correlated

Table 3 **Mean frequency of direct, indirect or no emotion selections as a function of group**

	Emotion selection		
	Direct (after first presentation)	*Indirect (after second presentation)*	*No emotion selection*
Neutral condition			
Autism group ($n = 28$)	6 (11%)	8 (14%)	42 (75%)
Control group ($n = 31$)	13 (21%)	15 (24%)	34 (55%)
Primed condition			
Autism group ($n = 28$)	40.5 (72%)	8.5 (15%)	7 (13%)
Control group ($n = 31$)	50 (81%)	6.5 (10%)	5.5 (9%)

Table 4 **Frequency of responses in which emotion was used as selection criterion as a function of group (autism and PDD-NOS) and condition**

	Emotion priority in selection				
	4	*3*	*2*	*1*	*0*
Neutral condition					
Autism group (*n* = 11)	1 (9%)	0 (0%)	1 (9%)	0 (0%)	9 (82%)
PDD-NOS group (*n* = 17)	1 (6%)	1 (6%)	2 (12%)	3 (18%)	10 (59%)
Primed condition					
Autism group (*n* = 11)	6 (55%)	1 (9%)	3 (27%)	1 (9%)	0 (0%)
PDD-NOS group (*n* = 17)	10 (59%)	5 (29%)	1 (6%)	1 (6%)	0 (0%)

Scores: 4 = emotion selection after first presentation of both trials, 3 = emotion selection after first presentation of one trial and second presentation of other trial, 2 = emotion selection after first presentation of one trial or after second presentations of both trails, 1 = emotion selection after second presentation of one trial, 0 = no emotion selection.

the measures of both variables in the autism spectrum group. The correlations between attention to emotions and verbal intelligence scores (primed condition, $r_{(28)} = -0.28$, n.s.; non-primed condition, $r_{(28)} = -0.17$, n.s.) or non-verbal intelligence scores (primed condition, $r_{(28)} = -0.03$, n.s.; non-primed condition, $r_{(28)} = 0.15$, n.s.) did not reach significance level.

Discussion

In correspondence with the results of Weeks and Hobson (1987), who studied low-functioning children with autism, the present experiment showed that high-functioning children from the autism spectrum also paid little attention to facial emotional expressions in other people. The current group of children from the autism spectrum gave less priority to emotion features as a selection criterion for the photographed faces than their typically developing peers. Instead, they more often selected photographs that were similar on non-emotion features, such as the presence of glasses or a moustache. However, this group difference only appeared in the 'neutral' condition, when circumstances bore no relation to possible relevance of emotional factors.

As expected, this difference between the autism spectrum and control groups disappeared when children were asked to focus on likely behavioural outcomes of the expressed emotion states. Children from both groups equally often sorted the presented photographs on emotion features when they were asked to select them according to possible future actions of the portrayed people. These findings suggest that children with autism are able to pair a positive or negative facial expression with a positive or

negative social consequence when asked to make a socially relevant decision. Yet, whereas most typically developing children were attentive to emotional expressions in both conditions, children with autism seemed only to take them into full account when the relevance of the emotional expressions was triggered by situational determinants. The variability of performances in both groups of children highlights the impact of task demands on children's attention to emotional expressions.

An important question is whether the present results could be attributed to differences in intellectual abilities between children with autism and typically developing children. Unfortunately, we could not directly answer this question since intelligence levels were not formally assessed in the control group. However, the existence of this relation seems unlikely in the present study. First, no correlations were found between the intellectual abilities and attention to emotions in the autism spectrum group, despite the fact that the variance of IQ scores in the autism group was relatively high. These results are in line with the lack of correlation between cognitive abilities and recognition of self-conscious emotions in a recent study of normally intelligent children with autism (Heerey et al., 2003). Furthermore, teachers who selected the control children were asked to choose average students, and the mean IQ scores of the autism group were indeed average. However, the lack of information on the intellectual abilities of the control group means that caution is required in the interpretation of the results of the present study.

The tendency of typically developing children to process emotional information under all circumstances – even when the situational context fails to show a direct relevance – suggests an automatic mechanism (Darwin, 1872). As argued in the introduction, infant behaviour suggests that children already intuitively understand some of these processes from the beginning of life (Caron et al., 1982). It is difficult to determine from our results whether children from the autism spectrum also have this kind of intuitive understanding or recognition. If they do, however, this recognition seems to have less impact if it is not explicitly required by the situation. Children with autism might naturally ignore other people's facial expressions when there is no direct need for them to deal with this kind of information. However, they also seem to be less aware that others' emotional states might *become* relevant. They do not seem to have acquired the knowledge that the chance that this will happen is relatively high compared to the possibility that knowledge about trivial elements like glasses or moustaches will become useful.

On the other hand, one could also argue that, even after attention to emotions is triggered in children with autism, their style of processing emotional information might differ fundamentally from typically developing

children. In particular, high-functioning children with autism are often said to compensate for their lack of 'natural' attention to emotions by cognitive means, sometimes referred to as the logico-affective hypothesis (Hermelin and O'Connor, 1985). Within this approach, it could be argued that the high-functioning children have sufficient intellectual skills to appreciate the functions of emotional expressions and attend to the social information that is contained within them. Their processing style can be considered as 'analytic and verbally mediated' rather than 'holistic and intuitive' (Grossman et al., 2000), and this may be related to weak central coherence. These children have been observed to exhibit problems integrating information into a meaningful whole (Frith, 2003; Happé, 1994). Indirect empirical support for a relation between weak central coherence and face processing can be seen in the finding that children with autism read emotional expressions more quickly than typically developing children when faces are presented upside-down (Hobson et al., 1988; Langdell, 1978), suggesting a piecemeal rather than holistic processing of facial information. Based on the present study, a decisive answer on the nature of the processing style of emotional expressions in children with autism cannot be provided. The same study carried out with low-functioning children might provide more insight into this issue.

Earlier findings of a preference for mouth over eye regions in face processing of children with autism (e.g. Joseph and Tanaka, 2003) were not confirmed in the present study. However, our task may not have been sensitive enough to illuminate these differences, as we did not use eye-track technology to measure the visual fixations of the children.

Nevertheless irrespective of the exact manner in which they process information about emotions, even in these intellectually able children with autism, attention to emotions was triggered less spontaneously than in their typically developing peers. The substantial increase of attention to emotions in the priming condition suggests that the addition of social relevancy to the task resulted in a qualitative shift to a new set of processing criteria rather than enhancing a strategy that was already being employed. This indicates a production deficit in the autism group: these children are neither blind nor shortsighted to emotional cues, but they do need assistance in deciding when and where to look. It also raises the question of whether subgroups of children differ in their sensitivity to social priming, especially with respect to interventions.

The problem remains that it will be hard to provide the children with explicit instructions about how to make use of emotional expressions in ambiguous social situations, as is often the case in daily life situations. Besides clarifying these contextual factors, a further goal would be to indicate, and possibly facilitate, the kinds of social and interpersonal

experiences in children with autism that make emotional expressions automatically salient in typical development. Without a clearly defined context, as was the case in the neutral condition, we can conclude that emotional expressions are no more meaningful than glasses or moustaches to children with autism. Frith recently argued that all three major approaches to autism can be unified by supposing a different kind of self-awareness in autism: 'an awareness that is *all* self and does not include the reflection of the self in other selves' (2003, p. 210). Awareness of and attention to emotional reactions in other people are essential elements in this missing 'looking glass self' (Cooley, 1902).

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