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Do Children with Autism Recognise Surprise? A Research Note

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We take a fresh look at emotion recognition in autistic children, by testing their recognition of three different emotions (happy, sad, and surprise). The interest in selecting these is that whereas the first two are typical "simple" emotions (caused by situations), the third is typically a "cognitive" emotion (caused by beliefs). Because subjects with autism have clear difficulties in understanding beliefs, we predicted they would show more difficulty in recognising surprise. In contrast, as they have no difficulty in understanding situations as causes of emotion, we predicted they would not show deficits in recognising happy and sad. These predictions were borne out, in a comparison with a group of normal children and in a group of subjects with mental handicap. This result shows the importance of fine-grain analysis in emotion-recognition tasks, and is discussed in relation to affective and theory of mind models of autism.

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INTRODUCTION

That children with autism suffer some sort of inability to experience *empathy* is both an old and a widely held idea (Kanner, 1943; Gillberg, 1992). For the most part, it is an idea based on clinical intuition. Children with autism simply seem disinterested in how you or anyone else might be feeling. Testing this idea has proven extraordinarily difficult, because empathy is a response to another person's "live" emotion. The best approximation so far has been to extract aspects of emotional information for testing under laboratory conditions. A series of interesting studies by Hobson and his colleagues (Hobson, 1986a, b; Hobson, Ouston, & Lee, 1988), for example, have tested if children with autism can recognise expressions of emotion, in the Ekman and Friesen (1975) tradition. These studies have found that children with autism perform significantly worse than nonautistic control groups on emotion-matching tasks, using either photographs, drawings, video or audio recordings. Similar findings have been reported by Tantam, Monoghan, Nicholson, and Stirling (1990).

In Hobson's early studies, the tasks involved matching different representations of emotional expression: faces with sounds; drawings with photographs; etc.—what we might call "across-channel" emotion recognition. When the task is simplified to one of recognising the emotion in photographs of faces alone, or voice alone—what we might call "single-channel" emotion recognition—performance by children with autism does not differ from that of mentally handicapped or normal controls (Hertzig, Snow, & Sherman, 1989; Hobson, Ouston, & Lee, 1989). Similarly, when the across-channel emotion recognition paradigm is used, autism-specific deficits only appear when subjects are matched on nonverbal mental age. When they are matched on verbal mental age, groups do not differ (Ozonoff, Pennington, & Rogers, 1990; Prior, Dahlstrom, & Squires, 1990). The empathy deficit, if there is one in autism, seems difficult to pin down.

A clue to why this should be so came from a different paradigm altogether: Tests of comprehension of the *causes* of emotion. Harris (1989) provided an important framework for conceptualising what young normal children understand about the causes of emotion, in his review of the literature on this question. To summarise, 3- to 4-year-old children understand that emotion can be caused by *situations* (Trabasso, Stein, & Johnson, 1981) and by *desires* (Wellman & Bartsch, 1988); by 4 to 6 years of age they also understand that *beliefs* affect emotions (Harris, Johnson, Hutton, Andrews, & Cooke, 1989).

When this paradigm was employed with children with autism, autism-specific deficits were found in comprehension of beliefs as causes of emotion, but not situations or desires (Baron-Cohen, 1991a). A similar finding was reported by Tan and Harris (1991). As previous work had

already shown that children with autism have inordinate difficulty in understanding beliefs (Baron-Cohen, 1989, 1991b; Baron-Cohen, Leslie, & Frith, 1985; Leslie & Frith, 1988; Perner, Frith, Leslie, & Leekam, 1989), it came as no surprise to discover that they also had difficulty in understanding beliefs as causes of emotion.

The surprise, if there is one, was that the subjects in the Baron-Cohen (1991a) and the Tan and Harris (1991) studies had no specific difficulty in understanding situations and desires as causes of emotion. This suggests that the notion that they have a global deficit in understanding affect is simply wrong. Rather, the deficit appears to be far more selective and subtle than that. It seems that when the subject is required to understand how cognition and emotion *interact* (as in beliefs shaping emotions), they are completely lost. When the task is one of understanding emotions simply as products of situations, they perform at ceiling. The deficit in understanding emotions thus appears to be secondary to the deficit in understanding cognitive mental states, such as beliefs, thoughts, etc.[1]

Both Wellman (1990) and Perner (1991) provide a useful handle on this possibly crucial distinction by separating emotions into "simple" vs. "cognitive" emotions. Simple emotions are those in which beliefs and other intentional mental states need not play a part. Cognitive emotions are those in which beliefs and other intentional mental states typically play a part. Before explaining how we made use of this distinction in our study of autism, we first elaborate on these concepts.

Cognitive vs. Simple Emotions: A Clarification of the Distinction

Our use of the distinction between simple and cognitive emotions rests on several important assumptions. First, we assume that any emotion can be either "simple" or "cognitive", depending on how a person observing it construes its current cause. Take happiness, for example, "Sam is happy because he gets a nice birthday present" is a straightforward example of a simple emotion: The emotion is produced by something in the real world. "Kate is happy because she *thinks* it's her birthday", is now an example of a cognitive emotion, because the emotion is produced by her belief, irrespective of whether this coincides with reality.

[1]Desire-based emotion, of course, is intermediate between situation-based and belief-based emotions. In the Baron-Cohen (1991a) study, performance on desire-based emotion by children with autism was only mediocre, but in line with a nonautistic mentally handicapped control group. It may be that a younger sample of children with autism would have shown deficits even on desire-based emotions, if specific delay in the development of a theory of mind is part of the problem in autism (Baron-Cohen, 1989, 1993). Phillips (1993) reports evidence that some aspects of desire may indeed be poorly understood by children with autism.

Second, we make the assumption that some emotions are *more typically* construed as simple. Happy, sad, angry, and afraid fall into this category. What this means is that when seeing these facial expressions we, as observers, are more likely to search for a situational cause (a nice situation, a nasty situation) to explain the emotional expression. Only when this is insufficient might we attribute a belief or desire as the cause of the emotion. Thus, if John looks sad when he opens his birthday present, then we are forced to reason that despite opening-birthday-presents comprising an apparently nice situation, he must have *wanted* something different, or must have *thought* he was going to receive something different. Most of the time, however, with expressions like happy, sad, angry, and afraid, a situation-based causal reasoning strategy works well enough.

Third, we make the assumption that some emotions are *more typically* construed as cognitive. Surprise, embarrassment, and interest fall into this category. What this means is that when seeing these facial expressions we, as observers, are more likely to attribute a belief as the cause of the emotion. For example, in recognising that someone is surprised, we usually attribute to the person a belief which is suddenly contradicted by reality. Thus, picture my face if I look in the dustbin and see a gun. In "reading" my facial expression as surprise you are likely to be assuming that I was not *expecting* to see a gun. You attribute to me the reasonable belief that dustbins contain paper, old food, etc., but *not* guns.

If we lacked the concept of belief or expectation (as young normal infants, or children with autism, are held to), the facial expression of surprise might still carry some meaning, because it could be interpreted at the simple level, in terms of a situational cause. For example, the facial expression of surprise might be attributed to a sudden stimulus change (e.g. a loud bang) in the situation, causing a startled look. But such a situation-based causal reasoning strategy will not work in many instances. For example, if the door bell rings and John opens the door to find a stranger standing there, we, as observers, can only make sense of his surprise expression by referring to his *expectation* being contradicted by reality (e.g. he was expecting that his brother was about to visit, etc.). Simply noting the situational factors (a stranger rings the doorbell) does not help us explain his surprise reaction.

Finally, it is important to clarify that the distinction between simple and cognitive emotions describes two different ways in which we, *as observers*, attempt to make sense of people's emotional expressions. It has nothing *necessarily* to do with the experience or expression of emotion. Thus, for people to experience or express surprise, they do not have to be aware of their belief, let alone be aware that their belief is contradicted by reality. Recent studies, for example, suggest that 3- to 4-month-old infants show

the surprise facial expression (Singer & Fagan, 1992), but this in no way implies that they are also aware of their own beliefs.

The distinction between emotions that are typically interpreted as cognitive and those that are typically interpreted as simple gave us the idea that we could return to employing the emotion-recognition paradigm with children with autism, this time to test them in a more fine-grain manner. Rather than looking at total scores on emotion-recognition tasks, as previous studies had done, we were interested in whether differences would emerge between the ability to recognise simple emotions versus the ability to recognise cognitive emotions. We chose happiness and sadness as typical simple emotions, and surprise as a typical cognitive emotion. Finally, in order to test for autism-specific deficits in a rigorous way, we matched our groups on verbal mental age, given the findings reviewed earlier.

THE EXPERIMENT

Subjects

We tested three groups of subjects: 15 children with autism; 12 children with mental handicap and without autism; and 15 normal 4-year-olds. The last two groups were to control for mental age, and to establish normative data using our test. The children with autism were all diagnosed according to established criteria (Rutter, 1978; DSM-III-R, 1987) and were attending a school for autism. The children with mental handicap were attending special schools for learning difficulties, whilst the normal children were attending nursery schools. All of these schools were in the London area, and contained a mix of social classes. The sex ratio in the control groups was approximately 1:1, whereas in the group with autism it was 4:1 (m:f) reflecting the predominance of males with autism (Wing, 1976).

The subjects with autism had a mean chronological age (CA) of 12.6 years (sd = 3.5 yrs, range 7.3–18.8), and a mean verbal mental age (VMA), as assessed using the TROG (Test of Reception of Grammar: Bishop, 1983), of 5.3 years (sd = 1.0 yrs, range 4.0–7.0). The group with mental handicap had a mean CA of 16.4 years (sd = 1.9 yrs, range 13.1–19.7), and a mean VMA of 4.5 years (sd = 0.6 yrs, range 4.0–5.25). This was, if anything, lower than that of the group with autism, ensuring that any autism-specific deficits that were found could not be attributed to language delay. The normal group had a mean CA of 4.4 years (sd = 0.3 yrs, range 4.1–4.9), and we assumed that their CA was roughly equivalent to their mental age (MA).

Given the earlier discussion on the role of VMA in emotion-recognition

studies, we felt that this was the crucial variable on which to match the groups. Nonverbal MA was not assessed, because from every study of autism to date where this has been measured, we could assume that this was either the same or higher than VMA, in the group with autism.

Method

Each child was tested individually in a quiet room in their school. The experimenter showed the child three sample photographs, one of a Happy face, one Sad, and one Surprised, and said "Here are some pictures of children. How does this one feel? And this one? And what about this one?" These questions checked if the child recognised the emotion shown, and served as a training phase for some of the children. Thus, if the child said "Don't know", or named any of these three pictures incorrectly, the experimenter supplied the correct name. If the child had a different word for any of these, the experimenter accepted these, providing these were nevertheless correct. Many of the children with autism and some children with mental handicap needed to be supplied with the words "surprise", and some of these subjects gave an entirely wrong word initially (e.g. "yawning", "hungry", or "frightened").

The child was then presented with 30 randomly arranged pictures of faces, these comprising 10 in each of the Happy, Sad, and Surprised categories. Half of these were photographs, taken from the *Fairburn System of Visual References* (1978), and half were drawings, taken from children's Ladybird books. All of these test stimuli, as well as the three sample photographs, were selected because they had been independently rated by two judges to be unambiguous examples of Happy, Sad, or Surprised faces.

As each picture was given to the child, the experimenter said: "Now, where does this one go?" The sample photograph was left above the pile that the child created, so that it was still available to be matched against, whilst each successive test item was placed on the growing pile beneath one of these three targets. At the end, the experimenter counted up the number of correct pictures in each set (i.e. the number of Happy faces under the Happy sample photo, the number of Sad faces under the Sad photo, and the number of Surprised faces under the Surprised photo), giving each child a score for each emotion out of 10.[2]

[2]With those subjects who did not put their pictures into neat piles, three boxes were used instead, with the target picture pasted on each box.

TABLE 1
Mean Correct Score of Each Group on Each Emotion (max = 10)

		Happy	*Sad*	*Surprise*
Autism	$\bar{x}$	8.9	8.7	5.5*
	sd	1.6	1.8	2.9
Mental handicap	$\bar{x}$	8.0	8.3	7.3
	sd	2.2	1.9	1.6
Normal	$\bar{x}$	9.0	8.4	8.1
	sd	1.4	1.6	1.6

*Surprise × Sad, $P < 0.01$. Autism × Other 2 groups, on Surprise, $F(2,39) = 5.86$, $P < 0.05$.

Results

The results are shown in Table 1. As can be seen, performance was good in most conditions in most groups. One-way ANOVAs of the mean scores on each emotion by group revealed that the groups did not differ significantly on Happy ($F(2,39) = 1.55$, $P > 0.05$) or Sad ($F(2,39) = 0.28$, $P > 0.05$), but they did differ significantly on Surprise ($F = 5.86$, df(2,39), $P < 0.05$). A *post hoc* Scheffe's test on this result confirmed that this was due to the group with autism being significantly worse than either of the other two groups ($P < 0.05$), who did not differ from each other.

A within-group, repeated measures, *t*-test indicated that the subjects with autism were significantly worse on Surprise condition than they were on either of the other conditions (Autism: Surprised × Sad, $t = 3.66$, $P < 0.01$). Similar *t*-tests were carried out to check for other within-group differences, but none were significant at the 0.05 level.

An error analysis revealed that when the subjects with autism made errors in the Surprise category, this tended to be due to them putting the Surprise picture into the Happy pile. Furthermore, for the normal children, the photographs were slightly easier than the drawings, whereas for the other groups, scores on the two forms of picture did not differ. There were no sex differences.

DISCUSSION

This study has taken a fresh look at emotion recognition by subjects with autism, by analysing recognition of typical situation-based ("simple") emotion (such as happy) vs. typical belief-based (or "cognitive") emotion (such as surprise) separately. On the basis of previous work showing deficits in understanding beliefs (Baron-Cohen et al., 1985; Perner et al.,

1989), it was predicted that recognition of cognitive emotions, in which emotions interact with beliefs, would be more likely to be specifically impaired in subjects with autism, whereas recognition of simple emotion would not. This prediction was confirmed. These results replicate those found using another paradigm, testing understanding of the causes of emotion (Baron-Cohen, 1991a).

This deficit is not explicable in terms of either language delay or low mental age, as performance by subjects without autism but with equivalent language and intellectual disabilities was significantly higher than in the group with autism. Nevertheless, it is clear that cognitive emotions also present a degree of difficulty for subjects with mental handicap, in that there was a trend towards worse performance on the Surprise condition in this group too. This is consistent with other studies reporting difficulties in emotion recognition (Maurer & Newbrough, 1987), but shows that whatever the nature of the problem with this group, it is not as severe as for subjects with autism.

Various alternative explanations for the pattern of results by the children with autism need to be noted. First, because surprise involves coding the eyes and the mouth whereas happy and sad can be coded simply by reference to the mouth, subjects with autism might have fared worse with surprise because they attended less to the eye region. Disentangling this explanation from the theory of mind explanation is not straightforward, given other evidence that the eye region of the face is used to infer a person's mental states (Baron-Cohen & Cross, 1992; Baron-Cohen, Campbell, Karmiloff-Smith, Grant, & Walker, 1993), but needs further examination.

Second, surprise often comprises *blends* of two emotions, whereas happy and sad do not. Thus, surprise is often blended with fear ("He was surprised to see a burglar in his living room") or with happy ("He was surprised to see a Valentine's card from Jane in his post tray"). More research is needed to determine whether the deficit reported here is specific to understanding cognitive emotions, or whether it is due to exposure to emotion blends.

In closing, given the good performance by subjects with autism in recognising typical simple emotions, such as Happy and Sad, we are forced to conclude that there is no *global* affective deficit. Rather, the deficit may be intrinsically related to their problems in the use of a theory of mind. Regarding the debate over the primacy of affective or cognitive factors in autism (Baron-Cohen, 1988), we would caution the reader from drawing simple conclusions. If we were able to examine *babies* with autism, deficits might be detected even in their perception of simple emotions. This prediction would be consistent with Hobson's (1993) theory that such basic deficits in infancy may be related causally to the later problems in both theory of mind and in understanding cognitive emotions. As things stand,

testing babies with autism is not possible, although recent prospective studies of high-risk toddlers (Baron-Cohen, Allen, & Gillberg, 1992) bring this goal a little nearer. Such infancy studies are needed before we are able to test the relationship between early affective understanding and later cognitive abilities such as theory of mind. In the absence of such infancy data, we must conclude at present that with a verbal mental age of 5 years, most children with autism can understand and recognise simple emotions but are lost when someone is surprised. Whether other typical cognitive emotions, such as embarrassment, are equally difficult for them, is worth testing in the future.

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