

Another Advanced Test of Theory of Mind: Evidence from Very High Functioning Adults with Autism or Asperger Syndrome

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Previous studies have found a subgroup of people with autism or Asperger Syndrome who pass second-order tests of theory of mind. However, such tests have a ceiling in developmental terms corresponding to a mental age of about 6 years. It is therefore impossible to say if such individuals are intact or impaired in their theory of mind skills. We report the performance of very high functioning adults with autism or Asperger Syndrome on an *adult* test of theory of mind ability. The task involved inferring the mental state of a person just from the information in photographs of a person's eyes. Relative to age-matched normal controls and a clinical control group (adults with Tourette Syndrome), the group with autism and Asperger Syndrome were significantly impaired on this task. The autism and Asperger Syndrome sample was also impaired on Happé's strange stories tasks. In contrast, they were unimpaired on two control tasks: recognising gender from the eye region of the face, and recognising basic emotions from the whole face. This provides evidence for subtle mindreading deficits in very high functioning individuals on the autistic continuum.

Keywords: Asperger Syndrome, autism, Tourette Syndrome, social cognition.

There is considerable evidence that the majority of children with autism have impairments in the development of a theory of mind (see Baron-Cohen, 1993, 1995, for reviews). Such a deficit may underlie the social, communicative, and imaginative abnormalities that are diagnostic of the condition, since a theory of mind is necessary for normal development in each of these three areas. The theory of mind deficit appears to be expressed very early, from at least the end of the first year of life, as joint attention deficits (Baron-Cohen, 1989a; Baron-Cohen, Allen, & Gillberg, 1992; Baron-Cohen, Cox, et al., 1996; Sigman, Mundy, Ungerer, & Sherman, 1986).

However, there is some evidence that appears to contradict the notion that a theory of mind deficit is a core cognitive deficit in autism. First, Bowler (1992) found that adults with Asperger Syndrome—who share the social and communicative symptoms of autism but who have no history of language delay—pass second-order theory of mind tests. Second-order theory of mind tests involve the subject reasoning about what one person thinks about another person's thoughts. Ozonoff and her colleagues (Ozonoff, Pennington, & Rogers, 1991; Ozonoff, Rogers, & Pennington, 1991) also found some adults with "high-functioning autism" or Asperger

Syndrome who passed second-order theory of mind tests. Both studies contradict the earlier finding from Baron-Cohen (1989b) that there is an impairment in theory of mind ability in autism. In the latter study, no subjects with autism passed the second-order test of theory of mind.

However, these studies cannot be taken as conclusive evidence for an *intact* theory of mind in such individuals with autism or Asperger Syndrome, because such second-order tests can easily produce ceiling effects if used with subjects with a mental age above 6 years. This is because children with normal intelligence pass second-order theory of mind tasks at about 6 years (Perner & Wimmer, 1985). It is unfortunate that many workers in this field have thought of second-order tests as "complex" or high-level tests of theory of mind. Certainly, they are more complex than first-order tests (in which the subject simply has to infer the thoughts of another person) (Baron-Cohen, Leslie, & Frith, 1985; Wimmer & Perner, 1983)—but recall that normal 4-year-old children pass first-order tests.

In short, neither first- or second-order tests are complex tests of theory of mind. They are simply probes for 4- or 6-year-old level skills, respectively, in this domain. Perhaps if they had been labelled as such, no-one would ever have thought of them as suitable tests of whether an *adult* (with autism, Asperger Syndrome, or any other condition) has a fully functional theory of mind. Finding a 30-year-old individual with autism, of normal intel-

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ligence, who can pass a theory of mind test at the level of a normal 6-year-old does not lead to the conclusion that they are necessarily normal in this domain. All we can conclude is that they have intact theory of mind skills at the level of a 6-year-old.

Happé's (1994a) study is the only one to take this issue seriously. She tested adults with autism or Asperger Syndrome on an "advanced" theory of mind task. This involved story comprehension, where the key questions in the task either concerned a character's mental states (the experimental condition) or physical events (the control condition). Happe's task was pitched at the level of a normal 8-9-year-old, and in this respect, it is certainly more advanced than previous tests of theory of mind. She found that adults with autism or Asperger Syndrome had more difficulty with the mental state stories than did matched controls, and that they used fewer appropriate mental state terms in their justifications of why characters behaved as they did.

In the present study we used a new, *adult* test of theory of mind competence, as another advanced test with which to test high-functioning adults with autism or AS. This extends Happé's line of research. The task involves looking at photographs of the eye region of the faces, and making a forced choice between which of two words best describes what the person (in the photograph) might be thinking or feeling. The task is called the "Reading the Mind in the Eyes" Task, or the Eyes Task for short.

The Eyes Task involved theory of mind skills in the sense that subject has to understand mental state terms and match them to faces (or parts of faces, in this case). The choice is always between two mental state terms, some of which are "basic", in Ekman's (1992) sense (such as happy, sad, angry, or afraid), and others of which are more "complex" (such as reflective, arrogant, scheming, planning, etc.). The forced-choice method for interpreting faces in terms of mental states has been used successfully before (Baron-Cohen, Riviere, et al., 1996). The task could equally be called a test of "mindreading" in that nothing in the test addresses whether the subject is using a "theory" or not. Here, as elsewhere, we use the terms "theory of mind" and "mindreading" interchangeably. An earlier study using this task found that parents of children with Asperger Syndrome perform significantly worse than matched controls, whilst performing significantly better on the Embedded Figures Task (Baron-Cohen & Hammer, in press a).

In the study reported below, three groups of subjects were compared on the Eyes Task: adults with autism or Asperger Syndrome, normal adults, and a clinical control group, adults with Tourette Syndrome. The latter was chosen because of the following similarities between autism, Asperger Syndrome, and Tourette Syndrome: (1) they all had intelligence in the normal range; (2) they had all suffered from a developmental disorder since childhood; (3) these disorders all cause disruptions to both normal schooling and normal peer relations; (4) these disorders are also all postulated to involve frontal abnormalities (Baron-Cohen, Cross, et al., 1994; Baron-Cohen, Robertson, & Moriarty, 1994; Bishop, 1992); (5) all have a sizeable genetic aetiology (Bolton & Rutter, 1990; Robertson, 1994); and (6) these disorders also all affect males more than females.

Naturally, there are many differences between autism and Asperger Syndrome on the one hand, and Tourette Syndrome on the other (e.g. different frontal abnormalities are implicated in these disorders), but the similarities they share serve to control for the presence of an organic, childhood-onset psychiatric disorder. We predicted that despite their psychiatric history, patients with Tourette Syndrome would be unimpaired on this advanced theory of mind test, whereas the subjects with autism or Asperger Syndrome would show a significant impairment.

We make the assumption that the Eyes Task is a theory of mind task because of the mental state attribution component. However, this assumption warrants direct testing. This was possible because subjects in the present study using the Eyes Task also took part in a separate study using Happé's (1994a) Strange Stories Task (Jolliffe, 1997). We predicted that if both the Eyes Task and the Strange Stories Task were indices of a relatively advanced theory of mind, then if subjects had difficulties with one of these tasks, they should also have difficulties with the other.

The Eyes Task also involves some other process, namely basic aspects of emotion recognition and face perception. In order to test if difficulties on the Eyes Task were specific to the mental state attribution component or were due to these other processes, we included two control tasks: a basic emotion recognition task (adapted from Ekman, 1992), and a gender recognition task.

Finally, if the Eyes Task was validated as an adult test of theory of mind, this afforded us the opportunity to test for a subtle sex difference in the normal group. Our folk psychology would lead us to expect that normal females may be superior to normal males in the domain of social sensitivity or empathy, but most previous theory of mind research has not used sufficiently subtle tests to evaluate if there is any basis to this (an exception is a study by Hall, 1977). We therefore analysed larger numbers of normal male and female subjects separately, to examine this possibility.

The Experiment

Subjects

Three groups of subjects were tested.

Group 1. This comprised 16 subjects with high-functioning autism (HFA, $N = 4$) or Asperger Syndrome (AS, $N = 12$). The sex ratio was 13:3 (m:f). The HFA Group all showed a history of "classical" autism (i.e. autism accompanied by language delay) and fulfilled established diagnostic criteria (American Psychiatric Association, DSM-IV, 1994). Note that because they were high-functioning adults, they would be considered "residual" cases. The AS Group all met the same criteria for autism, but without any clinically significant language delay (i.e. they had single words by age 2, or phrase speech by age 3, as reported by their parent). They thus met criteria for Asperger Syndrome as defined in ICD-10 (World Health Organisation, 1994). They were all of normal intelligence. As such, they are relatively rare. They can be considered as cases of "pure" autism or Asperger Syndrome, unconfounded by mental handicap.

They were recruited from a variety of clinical sources, as well as an advert in the National Autistic Society magazine, *Communication*.

Group 2. This comprised 50 normal age-matched adults (25 male and 25 female) drawn from the general population of Cambridge (excluding members of the University), all of whom had no history of any psychiatric condition (as established by self-report). They were selected randomly from the subject panel held in the University Department. IQ information was not collected on subjects in this group, but they were all assumed to have intelligence in the normal range.

Group 3. This comprised 10 adult patients with Tourette Syndrome (TS), also age-matched with Groups 1 and 2. The sex ratio was 8:2 (m:f), thus mirroring the ratio in Group 1. They were attending a tertiary referral centre in London, and had all been diagnosed by a leading expert in the field of Tourette Syndrome (Dr Mary Robertson), on the basis of meeting DSM-IV criteria for Tourette Syndrome.

The subjects with autism or Asperger Syndrome were selected for being of at least normal intelligence (i.e. scoring > 85) on the Wechsler Adult Intelligence Test Revised Edition (WAIS-R) (Wechsler, 1981: full scale, performance, and verbal IQ). The WAIS-R was used because of previous work showing discrepancies between performance and verbal IQ in these groups (Frith, 1989; Happé, 1994b). We therefore ensured that these subjects had an IQ > 85 on both verbal and performance scales.

The subjects with Tourette Syndrome were also selected for being in the normal IQ range, prorated from four subtests of the WAIS-R (Block Design, Object Assembly, Vocabulary, and Comprehension). This short version of the WAIS-R was administered to the subjects with Tourette Syndrome because of its brevity, since these subjects were only available for limited testing in this study. It correlates (.91) with full-scale WAIS-R IQ (Crawford et al., 1992).

Finally, subjects in the two clinical groups were selected for being able to pass two first-order false belief tasks (Baron-Cohen et al., 1985; Perner, Frith, Leslie, & Leekam, 1989), and a second-order false belief task

Table 1
Chronological Age (CA) and IQ of the Subjects in Each of the 3 Groups

	CA	WAIS-R IQ
Autism/Asperger Syndrome (N = 16)		
Mean	28.6	105.31
SD	9.7	13.0
Range	18-49	86-133
Normal (N = 50)		
Mean	30.0	—
SD	9.12	—
Range	18-48	—
Tourette Syndrome (N = 10)		
Mean	27.77	103.5
SD	7.81	10.0
Range	18-47	93-115

(Baron-Cohen, 1989b). This was so that if any deficits were found on the Eyes Task, they could be attributed to mindreading problems beyond a 6-year-old level. In fact, this did not lead to any of the clinical subjects being excluded.

Table 1 gives the subject characteristics in terms of chronological age (CA), and WAIS-R IQ. ANOVAs revealed no significant differences between the three groups on age ($p > .05$), or between the clinical groups in terms of WAIS-R.

Method and Design

The Eyes Task, the Strange Stories Task, and the two control tasks were presented in random order, to all subjects. The subjects were tested individually in a quiet room either in their own home, in our clinic, or in our lab at the University.

The Eyes Task

Items from the Eyes Task were first described by Baron-Cohen (1995) as an adult test of the "language of the eyes". This extends an earlier idea of Numenmaa's (1964) that there might be a "language of the face" for expressing mental states. The test comprises photographs of the eye region of 25 different faces (males and female). The faces were taken from magazine photos. All faces were standardised to one size (15 × 10 cms), and all were black and white, with the same region of the face selected for each photo—from midway along the nose to just above the eyebrow. Figure 1 shows a selection of the photo-

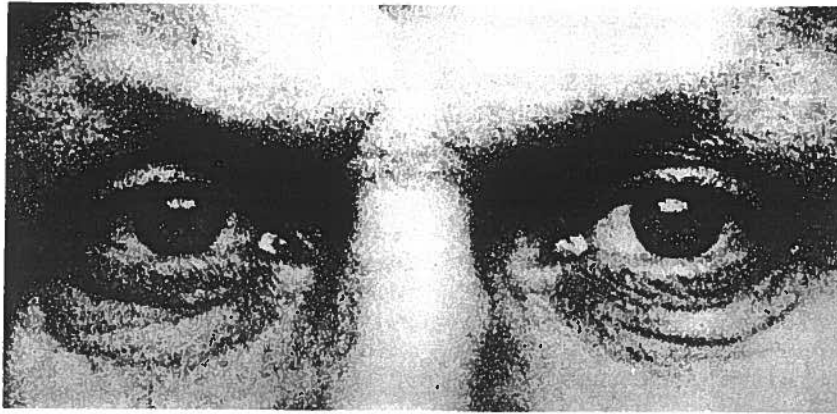
Table 2
Target Mental State Terms, and Their Foil Terms

No. ^a	Target term	Foil
1	Concerned	Unconcerned
2	Noticing you	Ignoring you
3	Attraction	Repulsion
4	Relaxed	Worried
5	Serious message	Playful message
6	Interested	Disinterested
7	Friendly	Hostile
8	Sad reflection	Happy reflection
9	Sad thought	Happy thought
10	Certain	Uncertain
11	Far away focus	Near focus
12	Reflective	Unreflective
13	Reflective	Unreflective
14	Cautious about something over there	Relaxed about something over there
15	Noticing someone else	Noticing you
16	Calm	Anxious
17	Dominant	Submissive
18	Fantatising	Noticing
19	Observing	Daydreaming
20	Desire for you	Desire for someone else
21	Ignoring you	Noticing you
22	Nervous about you	Interested in you
23	Flirtatious	Disinterested
24	Sympathetic	Unsympathetic
25	Decisive	Indecisive

^a Stimulus number.



(a) CONCERNED vs. Unconcerned.



(b) SERIOUS MESSAGE vs. Playful Message.

Figure 1. For legend see facing page.

graphs used (also the relevant mental state terms for each photo). Each picture was shown for 3 seconds, with a forced choice between two mental state terms printed under each picture. The Experimenter says to the subject "Which word best describes what this person is feeling or thinking?" The maximum score on this test is 25.

Construction of the Eyes Task

The target word to describe the mental state behind each pair of eyes was generated by four judges (two male and two female) in open discussion. A foil word was selected that was the semantic opposite of the target word, in all cases. These were then tested on a panel of eight judges (four male and four female) who were all independent raters, blind to the hypotheses of the study. On the target words there was unanimous agreement by all eight independent raters. The full set of mental state terms (and their foils) is shown in Table 2. Notice that the mental state terms include both basic and complex mental states.

Validity of the Eyes Task

The Eyes Task is designed to be a "pure" theory of mind test, at an advanced level. This is because, as far as we can see, the test itself involves no executive function component (no attention switching, inhibition, planning, etc., cf. Ozonoff et al., 1991; Russell, Mauthner, Sharpe, & Tidswell, 1991) and no

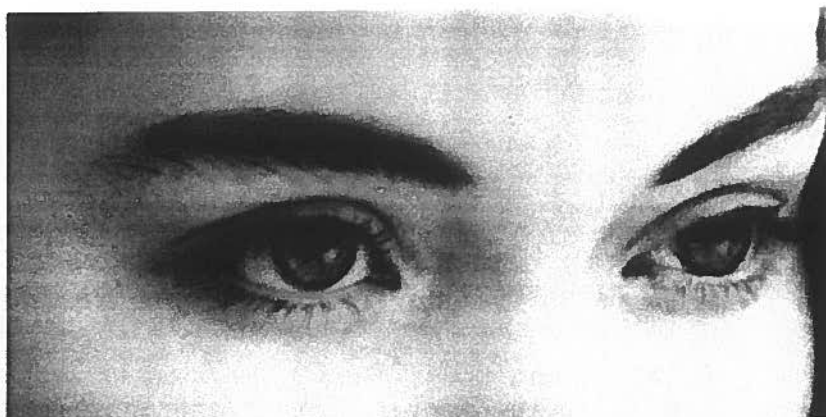
central coherence component (since there is little contextual information available, cf. Frith, 1989). This is not to say that such processes may not play a role in the development of a theory of mind—only that the task itself has no planning or context component. As mentioned earlier, in order to validate the Eyes Task as a theory of mind task, subjects in the two clinical groups were also tested on Happé's (1994a) Strange Stories. In the case of the subjects with autism and Asperger Syndrome, this was part of a separate study (Jolliffe, 1997). If the Eyes Task was indeed tapping theory of mind, then performance on the Eyes Task should correlate with performance on Happé's strange stories.

Control Tasks

Finally, in order to check whether deficits on the Eyes Task were due to other factors, we administered two control tasks to the subjects in Group 1.

Gender Recognition Task. This involved looking at the same sets of eyes in the experimental task, but this time identifying the *gender* of person in each photograph. This is a social judgement without involving mind reading, and allowed us to check if any deficits on the Eyes Task could be attributed to general deficits in face perception, perceptual discrimination, or social perception. This naturally had a maximum score of 25.

Basic Emotion Recognition Task (Emotion Task). This involved judging photographs of whole faces displaying the basic emotions (based on the Ekman categories). This was to



(c) REFLECTIVE vs. Unreflective.



(d) SYMPATHETIC vs. Unsympathetic.

Figure 1. Examples of stimuli from the Eyes Test. The forced-choice pair of descriptions were randomised in terms of left-right presentation, and offered in identical case and font. For clarity here, the correct description is in upper case.

Table 3
Performance on the Eyes Test

	Eyes Task	Gender control
Autism/Asperger Syndrome ($N = 16$)		
Mean	16.3 ^a	24.1
SD	2.9	0.7
Range	13–23	23–25
Normal ($N = 50$)		
Mean	20.3	23.3
SD	2.63	1.1
Range	16–25	22–25
Tourette Syndrome ($N = 10$)		
Mean	20.4	23.7
SD	2.63	0.9
Range	16–25	23–25

^a Autism/AS \times Normal, $t = -5.16$, $64df$, $p = .0001$;
Autism/AS \times TS, $t = 3.98$, $24df$, $p = .001$.

check whether any deficits on the Eyes Task could be attributed to a deficit in basic emotion expression recognition. Six faces were used, testing the following basic emotions: happy, sad, angry, afraid, disgusted, and surprised. Examples of the faces used are shown in Fig. 2. Note that the Basic Emotion Recognition Task differs from the Eyes Task in two ways:

Table 4
Performance by Males and Females in the Normal Group

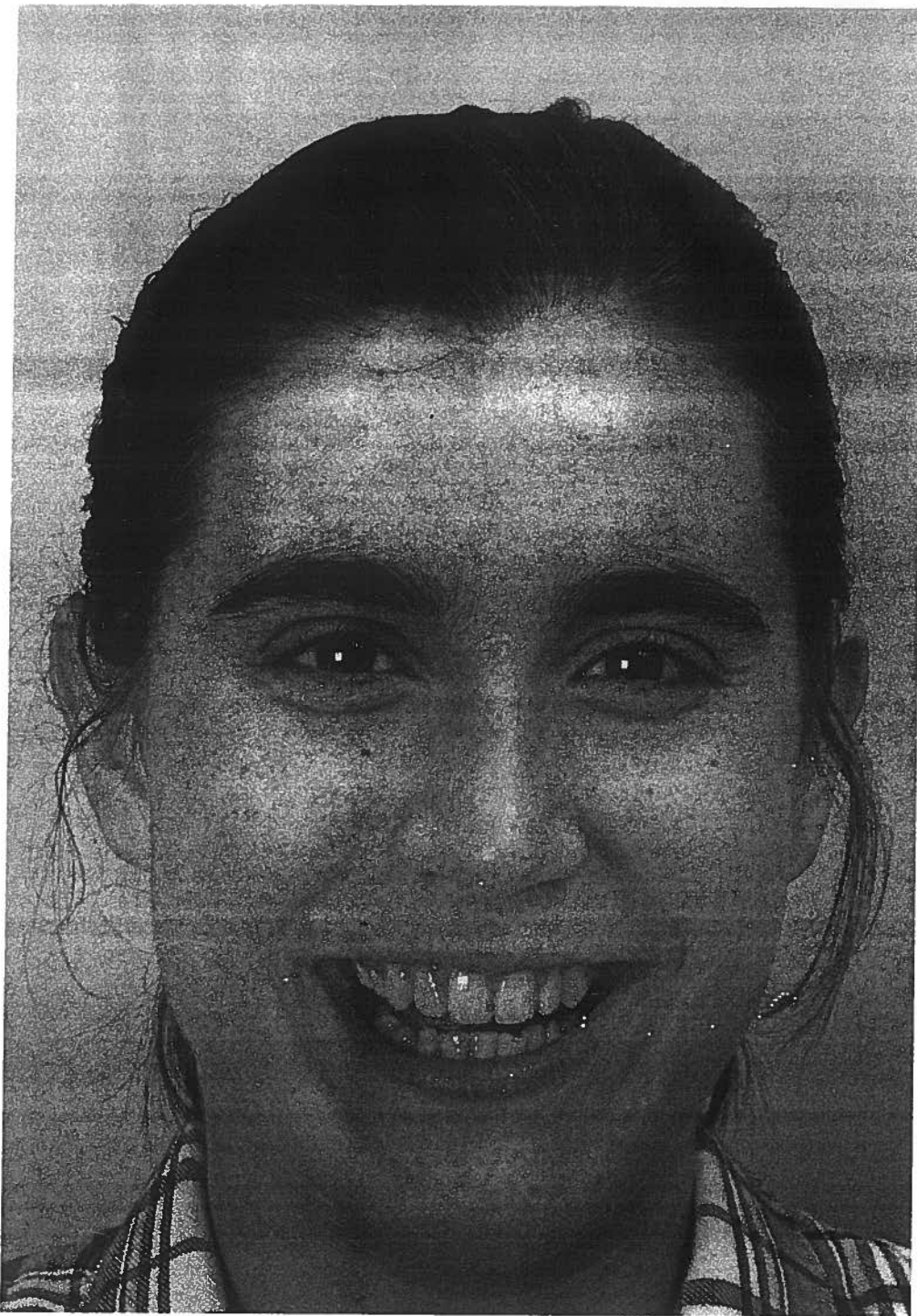
	Eyes Task	Gender control
Males ($N = 25$)		
Mean	18.8 ^a	24.0
SD	2.53	0.6
Range	16–22	23–25
Females ($N = 25$)		
Mean	21.8	23.8
SD	1.78	0.6
Range	20–25	23–25

^a $t = -4.8$, $48df$, $p = .0001$.

(1) the Emotion Task affords information from the whole face, whereas the Eyes Task has information from the eyes alone.
(2) The Emotion Task tests just the basic (six) emotions, whereas the Eyes Task tests the full range of mental states.

Results

The results on the Eyes Task from the between-groups analyses are shown in Table 3, and the results from the between-sex analysis in the normal group are shown in Table 4. To test a priori predictions on the Eyes Task, independent t -tests were used, with a significance level of

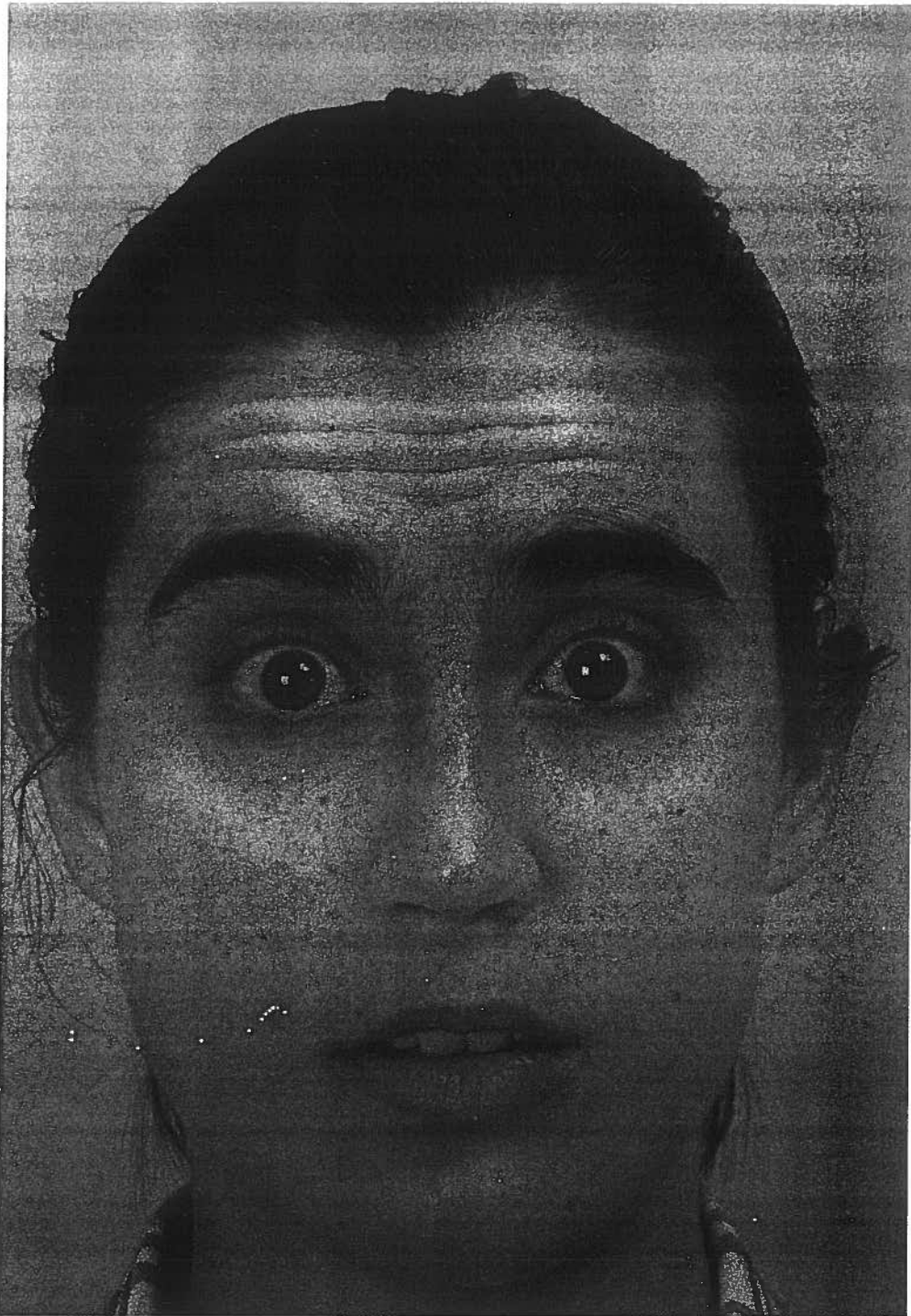


(a) HAPPY vs. Sad.

Figure 2. For legend see facing page.

$p < .01$ set to correct for carrying out multiple comparisons. The subjects with Tourette Syndrome did not differ from normal subjects (combined male and female) on this task ($t = 0.092$, $58df$, $p > .93$), but both control groups performed significantly better than the group with autism or Asperger Syndrome (Autism/AS \times Normal, $t = -5.16$, $64df$, $p = .0001$; Autism/AS \times TS, $t = -3.98$, $24df$, $p = .001$). In the normal group, as predicted, female

subjects performed significantly better than male subjects ($t = -4.8$, $48df$, $p = .0001$). The Autism/AS group difference remained significant even when that group was compared more conservatively to the normal male group ($t = 2.93$, $39df$, $p = .006$). Inspection suggested there was no difference between subjects with autism and Asperger Syndrome, though because of sample sizes this was not tested statistically.



(b) Angry vs. AFRAID.

Figure 2. Examples of the Basic Emotion Recognition Control Task. Here, the correct description is given in upper case. In the task, both descriptors had identical case.

It is of interest to look at individual performance. If one takes a cut-off of $> 15/25$ on the Eyes Test as being above chance (Binomial Test), then only 8/16 of the Autism/AS group were above chance, versus 10/10 of the TS group, and 50/50 of the Normal group. This is a highly significant difference (chi-square, $p < .01$).

On the Gender and Emotion Control Tasks, there were

no differences between the groups [Gender: $F(3, 69) = 0.3, p > .1$; Emotion: ceiling performance by all groups]. Within the Autism/AS group, there was no significant correlation between IQ and performance on the Eyes task ($r = -.08$). Finally, on Happé's Strange Stories, no subjects with Tourette Syndrome made any errors, but the subjects with autism or Asperger Syndrome made

errors, and were significantly impaired on this task, relative to controls. Full details of this task, including coding and results, are reported separately (Jolliffe, 1997).

Discussion

This study tested several predictions. First, that adults with autism or Asperger Syndrome, despite being of normal or above-average IQ, would nevertheless be impaired on a subtle theory of mind test. This prediction was confirmed. Second, that within the normal population, females would be significantly better on this test of theory of mind than males. This was also confirmed. This extends earlier work (Hall, 1977).

Regarding the autism/Asperger Syndrome impairment, this is not easily accounted for in terms of IQ, because these subjects were in the normal or above normal range, and because performance on the task by this group shows no significant correlation with IQ. It is also not easily accounted for in terms of being the result of having any developmental neuropsychiatric disability, since the subjects with Tourette Syndrome were unimpaired on this test. The impairment in the group with autism or Asperger Syndrome is also not easily accounted for, either in terms of what Frith (1989) calls "weak central coherence" (or a difficulty in using context), or in terms of "executive function". This is because the stimuli in this experiment are relatively "pure" theory of mind items—they are devoid of contextual information (save the person's expression in the eyes) and there is no requirement to "disengage from the salience of reality" (Russell et al., 1991).

The good performance by the group with Tourette Syndrome is interesting in the light of other studies suggesting frontal lobe, and executive-type, dysfunction in this syndrome (Baron-Cohen, Cross, Crowson, & Robertson, 1994; Baron-Cohen & Moriarty, 1995). To the extent that theory of mind depends on specific frontal processes (Baron-Cohen, Ring et al., 1994; Fletcher et al., 1995; Goel, Grafman, Sadato, & Hallett, 1995), these appear to be intact in patients with Tourette Syndrome.

We interpret the results as providing experimental evidence for subtle theory of mind deficits in individuals with autism or Asperger Syndrome, at later points in development and at higher points on the IQ continuum than have previously been demonstrated. The justification that the Eyes Task is indeed measuring theory of mind comes from four sources. First, the target words are mental state terms. Second, these are not just emotion terms, but include terms describing cognitive mental states. This is therefore more than just an emotion perception test. Third, the pattern of results from the Eyes Task mirrored the pattern of performance on the Happé Strange Stories—an existing advanced theory of mind task. Finally, the deficit on the Eyes Task was not mirrored on the two control tasks, suggesting that the poor performance by subjects with autism or Asperger Syndrome was not due to the stimuli being eyes, or to a deficit in extracting social information from minimal cues, or to a subtle perceptual deficit, or to basic emotion recognition. It should also be noted that some of the subjects with autism or Asperger Syndrome in our sample have university degrees, yet scored poorly on the Eyes

Task. This strongly suggests that this aspect of social cognition is independent of general intelligence.

We wish to point out, however, that even this "very advanced test" of theory of mind is still simpler than the real demands of live social situations. For one thing, our stimuli are static, in a way that the real social world never is. A closer approximation to the real social world might be based around a task assessing comprehension of movies. Anecdotally, many of our subjects with autism or Asperger Syndrome have told us that going to the movies is, for them, often a frustrating experience, a waste of their time. This is because the social action proceeds rapidly, and they find it hard to work out why a character did or said something (their intentions or motives), who knows what and who doesn't, and why the audience laughs at particular points in the film. It just all happens too fast. Movies, however, are not pure tests of mind-reading because they do involve central coherence and executive function. Hence our decision to use the Eyes Task here.

The finding of an impairment on the Eyes Task mirrors other difficulties that have been found in autism in relation to understanding the mentalistic significance of the eyes. For example, toddlers with autism have joint attention deficits, thought to reflect a failure to interpret gaze direction as a cue to the mental state of attention (see Baron-Cohen, 1994, for a review). Young children with autism have also been found to have difficulty in interpreting direction of gaze in terms of a person's goals or desires (Baron-Cohen, Campbell, Karmiloff-Smith, Grant, & Walker, 1995; Phillips, Baron-Cohen, & Rutter, 1992) and in terms of their intention to refer (Baron-Cohen, Baldwin, & Crowson, 1997). In addition, and in contrast to normal pre-school children, they are relatively blind to the significance of gaze direction as a cue to when someone is thinking (Baron-Cohen & Cross, 1992; Baron-Cohen et al., 1995).

Regarding the sex difference found in the normal group, this is of interest for several reasons. First, previous studies of theory of mind have not allowed for a subtle test of individual differences in this ability, being mostly all-or-none, pass-fail type tests. Sex differences might therefore simply have been missed. It may be that there are sex differences in the rate of development of theory of mind (and its developmental precursor, joint attention) in early childhood. This remains to be tested. Certainly, there are clear precedents for sex differences in cognitive development, the paradigm cases being female superiority in language development and male superiority in spatial skills (Halpern, 1992; Kimura, 1992; Witelson, 1976). Note that the female advantage on the mind-reading task could be taken to reflect genetic or socialisation factors (Baron-Cohen & Hammer, in press b). This remains to be investigated further.

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unfortunately their sources can no longer be traced. Liz Tennent kindly agreed to be photographed for stimuli shown in Fig. 2.

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