J. Child Psychol. Psychiat. Vol. 39, No. 5, pp. 747–753, 1998
Cambridge University Press
©1998 Association for Child Psychology and Psychiatry
Printed in Great Britain. All rights reserved
0021-9630/98 $15.00+0.00

The Frequency and Distribution of Spontaneous Attention Shifts between Social and Nonsocial Stimuli in Autistic, Typically Developing, and Nonautistic Developmentally Delayed Infants

J. Swettenham
Goldsmiths College, University of London, U.K.

S. Baron-Cohen
University of Cambridge, U.K.

T. Charman
University College London, U.K.

A. Cox, G. Baird, and A. Drew
Guy's Hospital, London, U.K.

L. Rees
Goldsmiths College, University of London, U.K.

S. Wheelwright
University of Cambridge, U.K.

Spontaneous shifts of attention were observed in autistic, typically developing, and nonautistic developmentally delayed infants. Three types of attention shifting behaviour were observed; (1) between an object and another object, (2) between an object and a person, and (3) between a person and another person. The two control groups shifted attention more frequently between an object and a person than between an object and another object or between a person and another person. The infants with autism showed a different pattern, shifting attention between an object and another object more than any other type of shift. Furthermore, infants with autism showed fewer shifts of attention between an object and a person, and between person and person, than did the two control groups. They also spent less time overall looking at people and looked more briefly at people and for longer durations at objects, compared to the two control groups. These results indicate an abnormality in social orientation in autism even at the early age of 20 months.

Keywords: Psychiatric disorder, autism, mental handicap.

Abbreviations: ADI-R: Autism Diagnostic Instrument-Revised; CA: chronological age; NVMA: nonverbal mental age.

Introduction

Kanner's (1943) original description of the clinical features of autism included abnormalities in reciprocal social interaction and communication and an insistence on sameness. This latter abnormality includes such behaviours as resistance to change, a tendency to focus on a particular aspect of the environment (such as a pattern on a carpet or the dial on a washing machine), and a tendency to engage in repetitive and ritualistic behaviours, particularly in early development. Such behaviours may reflect a basic deficit in attentional processing in autism.

Requests for reprints to: Dr John Swettenham, Department of Psychology, Goldsmiths College, University of London, New Cross, London SE14 6NW, U.K.

A number of recent experimental studies in autism have focused on attentional abnormalities (for example, Burack, 1994; Courchesne et al., 1994; Plaisted, O'Riordan, & Baron-Cohen, 1998; Townsend & Courchesne, 1994; Wainwright-Sharp & Bryson, 1993). Apart from the possible relation to the clinical features Kanner described as an insistence on sameness, one rationale for these studies has been that a basic attentional abnormality might underly deficits in higher-order cognitive processes, such as theory of mind, joint attention, and executive functioning, which have already been demonstrated in autism (Baron-Cohen, Leslie, & Frith, 1985; Mundy, Sigman, & Kasari, 1993; Ozonoff, Pennington, & Rogers, 1991). Because attentional processing is an important component in the execution of complex cognitive operations, an early-occurring attentional deficit in autism might therefore impede the development of higher-order cognitive and social skills. The present investigation examines the frequency and distribution of spontaneous attention shifts, in a semi-naturalistic setting, in infants with autism, typically developing, and nonautistic developmentally delayed infants at 20 months of age. We use the word attention to refer to orientation towards aspects of the environment rather than any other concept of attention.

A deficit in the ability to shift attention (in terms of information processing) rapidly and flexibly between stimuli in autism has been reported by Courchesne et al. (1994). In this experiment patients with autism, patients with acquired cerebellar damage, and IQ-matched normal individuals were compared using a task which required participants to shift their focus of attention rapidly back and forth between visual and auditory stimuli. Participants were required to detect infrequent target stimuli from a series of stimuli presented in each modality, and to alternate attention between visual and auditory modality as signalled by the appearance of a target stimulus. The results from Courchesne et al.'s study indicated that in comparison to matched control participants, participants with autism or acquired cerebellar damage were impaired in their ability to shift attention. Such attention-shifting deficits have also been found in these two types of patients in a task requiring shifts of attention within a single modality (Akshoomoff, 1992; Akshoomoff & Courchesne, 1994), and in tasks requiring rapid mental attentional orienting between visual spatial locations (Townsend, 1992; Townsend, Courchesne, & Egaas, 1992).

Consistent with the results of these studies of attention shifting, Wainwright-Sharp and Bryson (1993) have shown that individuals with autism are slower to respond to targets presented to the left or right of fixation in a Posner-type cueing task. In this experiment visual symbolic cues (arrows), presented at 100 msec or 800 msec, appeared at the centre of a screen either providing correct, incorrect, or neutral information as to the location of a target. With a cue duration of 100 msec, individuals without autism were quicker to locate a correctly cued target compared to an incorrectly cued target. In contrast, individuals with autism were not able to use these short duration cues in order to improve their reaction time in locating the target. This effect was thought to reflect an inability to allocate and coordinate attentional resources, described as covert orienting. However, when the cue duration was 800 msec, individuals with autism and without autism were quicker to respond to targets that had been correctly cued compared to those that were not correctly cued. This result suggested that individuals with autism may not be impaired in overt attentional orienting.

In addition to the attentional abnormalities documented in autism, there is a considerable body of work showing orientation to social stimuli, such as faces, to be deviant in autism. For example, it has been suggested that children with autism exhibit gaze avoidance and deviant patterns of reciprocal gaze (Rutter & Schopler, 1987). However, the question of how much or how little children with autism look at people remains in dispute. Thus, Sigman, Mundy, Ungerer, and Sherman (1986) found that children with autism with a mean age of 4 years and 5 months looked at their caregivers as much as normal children *although* not at the same times as children without autism. Mundy, Sigman, and Kasari (1994) reported that 3-year-old children with autism with high IQs made as much eye contact as typically developing children of the same age. However, this measure was taken in the context of assessing joint attention behaviours in which, it could be argued, the children made eye contact as a result of being encouraged to engage. Alternatively, Volkmar and Mayes (1990) assessed spontaneous gaze behaviour in older children with autism and found that they looked less at educational staff with whom they were familiar compared with a developmental delay group. In a semi-naturalistic setting, Dawson, Meltzoff, and Osterling (1995) observed head turns in response to nonsocial stimuli (a musical jack-in-the-box played for 6 seconds and a rattle being shaken) and social stimuli (the experimenter clapping hands six times and calling the child's name three times). It was found that children with autism more frequently failed to orient to all stimuli, and this failure was more extreme for social stimuli, when compared to a matched control group of children with Down's syndrome.

In a pioneering study on this issue, O'Connor and Hermelin (1967) presented children with autism, children with development delay, and typically developing children with pairs of displays in a viewing box and observed visual fixation time to any one display as well as amount of change in the direction of fixation. The results showed that all three groups looked more at a picture of a face than a scrambled face; all three groups looked more at a picture of a face and a scrambled face than any other stimuli; and the children with autism and typically developing children spent more time looking at a real face than a photographed face. However, when between-group comparisons were made it was found that the children with autism looked for less time at face stimuli than did control children. Further investigation revealed that this effect resulted from the fact that children with autism looked more briefly at *all* stimuli, both social and nonsocial, than did control children. Children with autism also showed fewer switches of gaze between one object and another than did control children. This study therefore suggested that the abnormal patterns of eye gaze often reported in autism may derive less from avoidance of social stimuli than from a more general attentional abnormality.

The current study assessed spontaneous patterning and distribution of attention between various social and nonsocial stimuli in infants with autism, in the absence of specific experimental cueing. To reiterate, we use a broad definition of attention here, defined as the selection of gaze direction and shifts of gaze direction. As a result of a recent prospective epidemiological study we identified a group of infants with autism who were 20 months of age at the time of the current study (Baron-Cohen et al., 1996). We not only assessed the distribution of attention between social and nonsocial stimuli, but also between different stimuli within these domains.

We predicted that if there is a general attentional abnormality in autism, which is manifest even at a very early age, there would not be a difference in the distribution of attention between social and nonsocial stimuli, above and beyond that shown by comparison groups of developmentally delayed and typically developing infants. However, a general attentional abnormality might lead to differences in the patterning of attention between stimuli within each domain. Alternatively, we predicted that if infants with autism exhibit a specific deficit in attention to social stimuli, their distribution of attention between social and nonsocial stimuli would be different compared to control groups, where infants with autism would attend more to nonsocial than to social stimuli. Finally, we predicted that this in itself would not lead to a difference in patterning of attention between stimuli in the nonsocial domain in the group with autism compared to the other two groups.

Method

Participants

The participants were 10 children with autism, 17 children with developmental delay, and 16 normal children. They were recruited from a random population of 16,000 children, all of whom had been screened in an epidemiological study of autism at 18 months of age using an instrument called the CHAT (see Baron-Cohen et al., 1996). The epidemiological aspects of the larger study are addressed in Baron-Cohen et al. (1996) and will not be discussed in detail here. Three risk groups were first identified according to their scores on the CHAT. The Autism Risk Group ($N = 12$) comprised children who failed protodeclarative pointing, gaze monitoring, and pretend play items on the CHAT. The Developmental Delay Risk Group ($N = 44$) comprised children who failed protodeclarative pointing, or who failed protodeclarative pointing and pretend play, but passed gaze monitoring. The No Risk Group ($N = 15{,}944$) comprised children who passed all three key items; these children were expected to be developmentally normal. Since the CHAT is designed as a screening instrument, there is no suggestion that the identified risk groups constitute diagnostic groups. Following the screening process, children from each of the three risk groups were followed up at 20 months of age in the clinic. All 12 children in the Autism Risk Group, 18 of the 44 children in the Developmental Risk Group (randomly selected), and 18 of the No Risk Group (randomly selected) were allocated into 3 experimental groups by the application of standardised diagnostic and psychometric instruments:

(1) *The autism group*: Autism is not commonly diagnosed before 3 years of age. We therefore employed rigorous criteria for the diagnosis of autism at 20 months of age, and in addition confirmed these diagnoses at 42 months of age using the same standardised instruments. Three independent measures were used to make a diagnosis of autism. First, the Autism Diagnostic Instrument-Revised, which has been shown to have a high sensitivity and specificity for diagnosing autism (ADI-R: Lord, Rutter, & Le Couteur, 1994); second, a pair of experienced clinicians (GB, AD) carried out a systematic assessment of communication skills and behaviour and made a diagnosis of autism according to established criteria (ICD-10; World Health Organisation, 1993); and third a different experienced clinician (SBC) rated videotapes of the children and made a diagnosis of autism according to ICD-10 criteria. Children who were diagnosed as having autism on two out of three measures were included in this study. Agreement between these three methods of diagnosis was high. Of the 10 infants diagnosed with autism in the study, 8 met criteria for autism on all 3 methods, and 2 met criteria on 2 out of 3 methods (kappa = 0.76). All 10 diagnoses of autism in this 20-month-old sample were confirmed at a follow-up assessment at 42 months of age, according to established criteria (ADI-R, Lord et al., 1994; ICD-10; World Health Organisation, 1993).

Table 1
Chronological Age (CA), Nonverbal Mental Age (NVMA), Expressive Language Age Raw Score (EL), and Language Comprehensive Raw Score (LC) for the Experimental Groups (SD in parentheses)

	Autism (A) ($N = 10$)	Developmental delay (DD) ($N = 17$)	Normal (N) ($N = 16$)
CA	20.7 (1.3)	19.9 (1.4)	20.1 (1.3)
NVMA[a]	17.5 (1.9)	17.7 (1.9)	20.9 (1.6)
EL[b]	6.4 (3.8)	8.1 (3.4)	16.0 (4.2)
LC[c]	4.9 (4.0)	5.4 (2.9)	16.6 (6.7)

[a] Griffiths scores expressed as mental age in months, calculated from the three subscales A, D, and E: ANOVA $F(2,40) = 18.0$, $p < .01$; post hoc Scheffe test A, DD < N, $p < .01$.
[b] Reynell Expressive Language raw score: ANOVA $F(2,40) = 25.7$, $p < .01$; post hoc Scheffe test A, DD < N, $p < .01$.
[c] Language Comprehension raw score: ANOVA $F(2,40) = 27.3$, $p < .01$; post hoc Scheffe test A, DD < N, $p < .01$.

(2) *The developmental delay group*: The 17 infants in the developmental delay group had a nonverbal mental age (NVMA) of 3 or more months below their chronological age (CA) on the Griffiths Scale of Infant Development (Griffiths, 1986), and had 5 or fewer words. This criterion was employed on the basis that less than 5% of children at 20 months old have 5 or fewer words (Fenson et al., 1993). None of the children in this group had autism as assessed above.
(3) *The normal group*: The children in the normal group did not meet any of the criteria for the two groups described above and were free of any other clinical diagnosis.

Ten of the 12 children in the Autism Risk Group met criteria for autism and the 2 remaining children in this group met criteria for developmental delay. Because of technical difficulties with the filming, it was not possible to include all the children in the present study. Thus, the final groups for the study were the 10 children with autism, 17 of the children with developmental delay, and 16 of the children who met neither criteria and were free from other clinical problems (the developmentally normal group). The descriptive data (CA, NVMA, and language age measured by raw scores on the Verbal Comprehension and Expressive Language subscales of the Reynell Language Scale [Reynell & Huntley, 1985]—raw scores were used since some participants scored below the floor for assigning a language age equivalent) for the three groups is shown in Table 1. The children in the normal group had a higher NVMA, Verbal Comprehension, and Expressive Language than the children in both the autism group and the developmental delay group (both ANOVA $p < .01$). There were no differences between the autism and developmental delay groups on any of the measures.

Procedure

Each child was filmed for approximately 5 minutes during a sequence of free play. Both parents and two experimenters were present during the session, but only interacted with the child if the child was the initiator. Five different toys had been laid out on the floor of the room before the parents and child entered. The session took place either in the clinic or, in the case of six of the children (two from the autism group and four from the developmental delay group) the session took place in a quiet room at the child's home. In both cases the room was cleared of all other toys. The toys supplied were: (1) a piece of coloured cloth; (2) two plastic bricks; (3) a teddy bear; (4) a duck inside a transparent ball; and (5) a toy typewriter. On entering the room the child was told "You can play with the toys if you want to". This was the only instruction given.

The videotape was then analysed by two independent judges, blind to the diagnosis of the children, using frame-by-frame slow motion with a timer accurate to a 10th of a second. The judges recorded whether the child was looking at: (1) an object (defined as any of the five toys, or any other object in the room); (2) a person (this was only scored if the child was looking at the person's face); or if the child was (3) unfocused (time spent looking at neither an object or a person—this consisted of periods of time where the child was getting up from the floor or moving across the room). The duration of each category of "look" was recorded. Since looking behaviour was recorded sequentially over the 5-minute period, this also allowed us to analyse how often and to what the child shifted attention (i.e. changed what they were looking at). In particular, we recorded how often the child shifted attention in any one of the following three ways:

(1) one object and another object;
(2) an object and a person;
(3) a person and another person.

Results

Two judges, blind to the diagnosis of the children, analysed the tapes and showed acceptable inter-rater reliability in their scoring (Pearson's $r > .8, p < .01$ for all measures). The following measures were analysed: mean duration of look at object, person, or unfocused; percentage time looking at objects, person, or unfocused; and frequency of shifts per minute (between object and object, object and person, and person and person).

Analysis of the Percentage of Time Looking

Figure 1 shows the percentage of time looking at objects, people, or unfocused for each group. These data were analysed by a mixed ANOVA with one between-subjects factor of group (autistic, developmentally delayed, and developmentally normal) and one within-subjects factor of direction of look (objects, people, unfocused). This revealed a significant main effect of direction of look, $F = 59.2$, $p < .01$, and a significant group by direction of look interaction ($F = 4.36$, $p < .05$). Simple effects of this interaction revealed that there was no significant difference between the groups in percentage of time engaged in unfocused "looking" ($F < 1$). However, there was a significant effect of group in the percentage of time looking at objects ($F = 3.4$, $p < .05$). Tukey's pairwise comparisons (.05 level) revealed that the group of children with autism spent more time looking at objects than the group of children with developmental delay (means = 73.7%, 52.7% respectively), although there was no significant difference between the autistic group and the normal group in the percentage of time spent looking at objects. Simple effects also revealed an effect of group for the percentage of time spent looking at people ($F = 13.3$, $p < .01$). Tukey's pairwise comparisons (.05 level) revealed that the autistic group spent less time looking at people than either the developmental delay group or the normal group (4.9%, 27.5%, and 28.2% respectively).

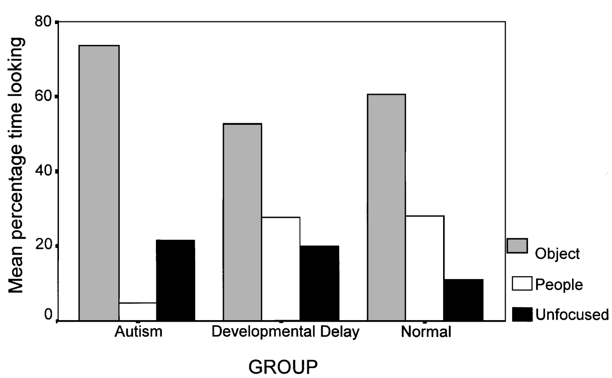

Figure 1. Percentage time attending to (looking at) objects, people, or unfocused for the three groups.

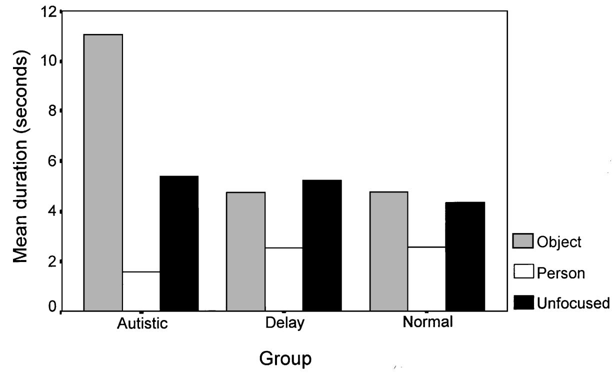

Figure 2. Mean duration of look at objects, people, or unfocused for the three groups.

Simple effects also revealed that there was a significant difference within the autistic, developmental delay, and normal groups between the percentage of time looking at objects, people, or unfocused (Fs = 25.05, 14.19, 100.3, respectively, $p < .01$). Tukey's pairwise comparisons (.05 level) of the percentage of times within each group revealed that the autistic, developmental delay, and normal groups all spent a greater percentage of time looking at objects (73.7%, 52.7%, 61.2% respectively) than at people (4.9%, 27.5%, 28.2% respectively) or unfocused (21.4%, 19.6%, 11.2% respectively). Therefore, all three groups showed a similar pattern in that they all spent a greater percentage of time looking at objects than at people or unfocused.

Analysis of Duration of Look

Figure 2 shows the mean duration of look at objects, people, or unfocused for the three groups. These data were analysed by a mixed ANOVA with one between-subjects factor of group (autistic, developmentally delayed, and developmentally normal) and one within-subjects factor of mean duration of look (objects, people, unfocused). This revealed a significant main effect of group ($F = 6.34, p < .05$), of duration of look ($F = 16.47$, $p < .05$), and a significant group by duration of look interaction ($F = 11.97$, $p < .05$). Simple effects of this interaction revealed that there was no significant difference between the groups in duration of unfocused look ($F < 1$). However, there was also no significant difference

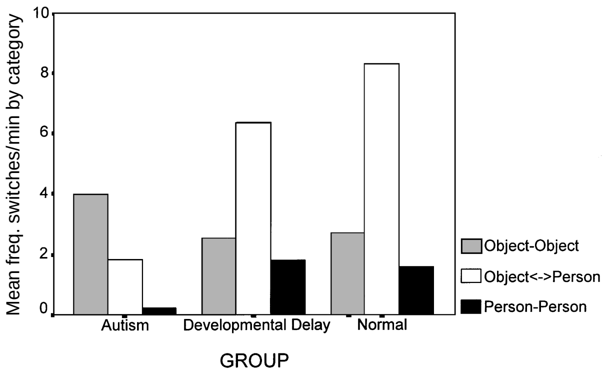

Figure 3. Mean frequency of shifting per minute by type of shift for the three groups.

between the groups in duration of look at people ($F = 3.24$, $p = .05$). Tukey's pairwise comparisons revealed that both the developmental delay group and the normal group differed significantly from the autism group (2.5, 2.5, 1.5 seconds, respectively). That is, the mean duration of look at people was shorter for the autistic group than for either developmental delay or the normal group. There was also significant effect of group in mean duration of look at objects ($F = 6.6$, $p < .05$). Tukey's pairwise comparisons (.05 level) of this effect revealed that both the developmental delay group and the normal group differed significantly from the autistic group but not from one another (4.7, 4.7, and 11.1 seconds, respectively). Therefore, the mean duration of look at objects was longer for the autistic group than for either the developmental delay group or the normal group.

Simple effects analysis also revealed that there was a significant difference within the autistic, developmental delay, and normal groups, between mean duration of look at objects, people, and unfocused (Fs = 6.23, 6.4, and 7.5 respectively, $p < .05$). Tukey's pairwise comparisons (.05 level) revealed that the autistic, developmental delay, and normal groups looked for a shorter duration at people (1.6, 2.5, 2.5 seconds, respectively) than they did at objects (11.1, 4.7, 4.7 seconds, respectively) or unfocused (5.4, 5.2, 4.3 seconds, respectively). For all three groups there was no significant difference between the duration of look at people and unfocused. Therefore all three groups showed a similar pattern of duration of look, where the duration of look at people was shorter than at objects or unfocused.

Analysis of Attention Shifting

Figure 3 shows the mean frequencies per minute of three types of attentional shift: between object and object, object and person, and person and person. These data were analysed by a mixed ANOVA with one between-subjects factor of group (autistic, developmentally delayed, and developmentally normal) and one within-subjects factor of type of shift (between object and object, object and person, and person and person). This analysis revealed a significant main effect of group ($F = 9.05$, $p < .05$), of type of shift ($F = 44.97$, $p < .05$), and a significant group by type of shift interaction ($F = 11.97$, $p < .05$). Simple effects of this interaction revealed that there was no significant difference between the groups in frequency per minute of object and object shifting ($F < 1$). However, there was a significant effect of group in frequency per minute of shifting attention between object and person and between person and person (Fs = 31.9, 5.05, respectively, $p < .05$). Tukey's pairwise comparisons of these effects showed that the developmental delay and normal groups both differed significantly from the autistic group but not from one another. The means for switches per minute between object and person were 6.43 in the developmentally delayed group, 8.31 in the normal group, and 1.83 in the autistic group. The means for switches per minute between person and person were 1.79 for the developmentally delayed group, 1.59 for the normal group, and 0.21 for the autistic group. Therefore, the developmental delay and normal groups showed more attentional shifting in those categories involving people than did the autistic group.

Simple effects analysis also revealed that there was a significant difference within the autistic group between frequency per minute of switching attention between object and object, object and person, and person and person ($F = 4.3$, $p < .05$). Tukey's pairwise comparisons (.05 level) showed that there was significantly more switching between object and object (3.98 switches per minute) than between person and person (0.21 switches per minute) within the autistic group. The autistic group also made almost twice as many switches per minute between object and object (3.97) than between object and person (1.83), although there was no significant statistical difference between these measures. Simple effects analysis revealed a significant difference within the developmental delay group and the normal group between frequency per minute of switching attention between object and object, object and person, and person and person (Fs = 27.5, 71.2, respectively, $p < .01$).

Tukey's pairwise comparisons (.05 level) of these effects revealed that both of these groups showed significantly more attention switching between object and person than between object and object and between person and person. Hence, the developmental delay group and the normal group showed a different pattern of attention switching compared to the autistic group. The developmental delay group and the normal group showed more attentional switching between object and person than either object and object or person and person. In contrast, the autistic group showed more attentional switches between object and object than between person and person, but no difference in switches between object and object and object and person.

Discussion

In this study, we observed the spontaneous distribution and patterning of attention, in terms of looking behaviour, in infants with autism, infants with developmental delay, and normal infants. Analysis of the percentage of time spent looking at people, objects, or unfocused revealed that the infants with autism spent less time looking at people than did the infants with developmental delay or the normal infants. Results also revealed that the infants with autism spent more time looking at objects than did the developmental delay group. Further analysis was carried out comparing the duration of each look. These results showed that infants with autism looked for shorter durations at people than did the infants with developmental delay or the normal infants; and that the infants with autism looked for longer durations at objects than did the two comparison groups.

Infants with autism also showed less attention shifting overall than the two control groups. Furthermore, they showed a different pattern of attention shifting involving social stimuli compared to the nonautistic children. Infants in the developmental delay and the normal groups showed a similar pattern in that they shifted attention between an object and a person significantly more frequently than between objects and between two people. This preference for attentional shifting between categories of objects that involved social stimuli was not shown by the infants with autism. By contrast, from the graph in Fig. 3 it is clear that the preference in infants with autism was to switch attention between object and object (although there was no *statistical* difference in switching attention between object and object and between object and person). Furthermore, when frequency of type of shifting was compared across groups, it was found that the infants with autism showed fewer shifts of attention between object and person and between person and person compared to the two control groups.

In short, infants with autism exhibited a pattern of attentional behaviour which was the complementary opposite to that of the two nonautistic control groups. Specifically, infants with autism looked less and for shorter durations at people, looked more and for longer durations at objects, and switched attention less frequently between social and nonsocial stimuli. This pattern of results is therefore highly consistent with theories predicting that children with autism have a specific deficit in attending to social stimuli. For example, Baron-Cohen (1995) has argued for a deficit in neurocognitive mechanisms dedicated to the processing of social information such as direction of eye gaze (the Eye Direction Detector) and joint attention (Shared Attention Mechanism). Thus, the lack of attention to people that we observed here in infants with autism can be seen as an early expression of such deficits. Furthermore, the lack of attention to social stimuli at this early age could lead to the deficits in eye gaze and eye contact observed in some studies in older children with autism (Rutter & Schopler, 1987; Volkmar & Mayes, 1990).

Alternatively, the lack of attention to social stimuli that we observed here may arise from a more general avoidance of complex stimuli. People are, of course, complex configural stimuli. At least one study has found that children with autism fixated complex visual stimuli presented on a computer screen for shorter times, relative to controls (Verbated, Roelfs, van Engeland, Kenemans, & Slangen, 1991). It has also been found by Davies et al. (Davies, Bishop, Manstead, & Tantam, 1994) that children with autism performed worse than normal children on a matching to sample task involving both facial and configural nonfacial stimuli. These studies raise the possibility that abnormalities in attention to social stimuli arise because of a general deficit in the processing of complex configural stimuli rather than a specific deficit in mechanisms devoted to the processing of social stimuli.

The fact that the three groups did not differ significantly in frequency of attention shifting between object and object seems to suggest that these infants with autism did not show a general abnormality in attention shifting between nonsocial environmental stimuli. Nonetheless, as is apparent in Fig. 3, the infants with autism showed less attention shifting overall than the other two groups. Thus, it remains possible that infants with autism do shift attention less often between nonsocial stimuli than other groups but that the experimental set-up used here prevented this from being observed. It may, therefore, have been the case that the opportunity to switch attention between object and object in the developmental delay and normal groups was reduced because these other groups spent more time switching attention between social and nonsocial stimuli than the infants with autism, thus reducing the opportunity to switch attention between one object and another. Frequency of attention shifting between object and object in these other groups may therefore have been increased had social stimuli not been present and a difference between the infants with autism and the control groups may have emerged. This possibility, that infants with autism may show less frequent switches of attention between stimuli, would be consistent with the deficit in attention shifting that has frequently been observed in older individuals with autism by Courchesne and his colleagues (1994).

Finally, we need to consider explanations for the differences between the results of the current study and that of O'Connor and Hermelin (1967), which also explicitly compared attention to social and nonsocial stimuli in children with autism. Whereas the main result of the current study was that the infants with autism looked less at people and more at nonsocial objects, O'Connor and Hermelin found that the children with autism in their study spent more time looking at facial stimuli than at other nonfacial stimuli. Furthermore, in contrast to the present study, which found that infants with autism looked longer at objects compared to the two control groups, the children with autism in O'Connor and Hermelin's study looked more briefly at all stimuli compared to normal children.

This latter difference might be explained by differences in procedure employed in the two studies: children in O'Connor and Hermelin's study were required to look inside a box at two alternative stimuli whereas the infants in our study were unrestricted in terms of what they could look at and for how long. However, differences in procedure are unlikely to explain the difference in time spent looking at social versus nonsocial stimuli between the two studies. The most obvious explanation here is age—children in O'Connor and Hermelin's study had a mean chronological age of 11 years and 4 months whereas the infants in the current study were aged 20 months. This raises the possibility that an abnormality in orientation to social stimuli, present at an early age in autism, diminishes during development.

In summary, this observational study of infants of 20 months of age establishes important differences in attentional orientation to stimuli in the environment between children with autism, developmental delay, and typically developing children. The primary finding, that infants with autism spontaneously orient less to social stimuli than do the other groups, is a strong indication of social abnormality at a very early age in autism. Infants with autism also showed little attention shifting involving social stimuli. This lack of attention to social stimuli early on has obvious implications for delays in the development of joint attention and other social behaviours that have been observed in autism (see for example, Mundy, 1995; Mundy & Sigman, 1989; Mundy et al., 1993).

Acknowledgements—This project was funded by a grant from the Medical Research Council to Simon Baron-Cohen, Tony Cox, and Gillian Baird. Special thanks to Kate Plaisted for advice and discussion and to Eric Taylor and Joanna Giannapoulou from the MRC Child Psychiatry Unit at the Institute of Psychiatry for consultations regarding the attention assessment they are developing. Thanks also to Chris Jarrold, Chris Moore, Juan-Carlos Gomez, and Sue Leekam for discussions. Finally, the participants were drawn from a large population screening study, which would not have been possible without the help of Natasha Nightingale and Health Visitors in the South East Thames Health Region.

References

Akshoomoff, N. A. (1992). *Neuropsychological studies of attention and the role of the cerebellum*. Unpublished doctoral dissertation, University of California, San Diego, and San Diego State University.

Akshoomoff, N. A., & Courchesne, E. (1994). Evidence for a shifting attention deficit in patients with damage to the cerebellum. *Journal of Cognitive Neuroscience*, *6*, 388–399.

American Psychiatric Association. (1987). *Diagnostic and statistical manual of mental disorders* (Revised 3rd Ed.). Washington, DC: Author.

Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind*. Cambridge, MA: MIT Press/Bradford Books.

Baron-Cohen, S., Cox, A., Baird, G., Swettenham, J., Drew, A., Nightingale, N., Morgan, K., Drew, A., & Charman, T. (1996). Psychological markers of autism at 18 months of age in a large population. *British Journal of Psychiatry*, *168*, 158–163.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition*, *21*, 37–46.

Burack, J. A. (1994). Selective attention deficits in persons with autism: Preliminary evidence of an inefficient attentional lens. *Journal of Abnormal Psychology*, *103*, 535–543.

Courchesne, E., Townsend, J., Akshoomoff, N., Saitoh, O., Yeung-Courchesne, R., Lincoln, A., James, A., Haas, R., Schreibman, L., & Lau, L. (1994). Impairment in shifting attention in autistic and cerebellar patients. *Behavioural Neuroscience*, *108*, 848–865.

Davies, S., Bishop, D., Manstead, A. S. R., & Tantam, D. (1994). *Journal of Child Psychology and Psychiatry*, *35*, 1033–1059.

Dawson, G., Meltzoff, A., & Osterling, J. (1995). *Children with autism fail to orient to naturally occurring social stimuli*. Paper presented at the meeting of the Society for Research in Child Development, Indianapolis.

Fenson, L., Dale, P., Reznick, S., Thal, D., Bates, E., Hartung, J., Pethick, S., & Reilly, J. (1993). *The MacArthur Communicative Development Inventories*. San Diego, CA: Singular Publishing Group.

Griffiths, R. (1986). *The abilities of babies*. London: University of London Press.

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child*, *2*, 217–250.

Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism Diagnostic Interview-Revised: A revised version of the diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders*, *24*, 659–685.

Mundy, P. (1995). Joint attention and social-emotional approach behaviour in children with autism. *Development and Psychopathology*, *7*, 63–82.

Mundy, P., & Sigman, M. (1989). The theoretical implications of joint-attention deficits in autism. *Development and Psychopathology*, *1*, 173–183.

Mundy, P., Sigman, M., & Kasari, C. (1993). Theory of mind and joint attention deficits in autism. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds.), *Understanding other minds: Perspectives from autism* (pp. 181–204). Oxford: Oxford University Press.

Mundy, P., Sigman, M., & Kasari, C. (1994). Joint attention, developmental level, and symptom presentation in autism. *Journal of Development and Psychopathology*, *6*, 389–401.

O'Connor, N., & Hermelin, B. (1967). The selective visual attention of psychotic children. *Journal of Child Psychology and Psychiatry*, *8*, 167–179.

Ozonoff, S., Pennington, B. F., & Rogers, S. L. (1991). Executive function deficits in high-functioning autistic individuals: Relationship to theory of mind. *Journal of Child Psychology and Psychiatry*, *32*, 1081–1105.

Plaisted, K., O'Riordan, M., & Baron-Cohen, S. (1998). Enhanced discrimination of novel, highly similar stimuli by adults with autism during a perceptual learning task. *Journal of Child Psychology and Psychiatry*, *39*, 767–777.

Reynell, J., & Huntley, M. (1987). *Reynell Developmental Language Scales*. Windsor, U.K.: NFER.

Rutter, M., & Schopler, E. (1987). Autism and pervasive developmental disorders: Concepts and diagnostic issues. *Journal of Autism and Developmental Disorders*, *17*, 159–186.

Sigman, M., Mundy, P., Ungerer, J., & Sherman, T. (1986). Social interactions of autistic, mentally retarded, and normal children and their caregivers. *Journal of Child Psychology and Psychiatry*, *27*, 647–656.

Townsend, J. (1992). *Abnormalities in brain structure and function underlying the distribution of visual attention in autism*. Unpublished doctoral dissertation, University of California, San Diego, and San Diego State University.

Townsend, J., & Courchesne, E. (1994). Parietal damage and narrow "spotlight" spatial attention. *Journal of Cognitive Neuroscience*, *6*, 220–232.

Townsend, J., Courchesne, E., & Egaas, B. (1992). *Visual attention deficits in autistic adults with cerebellar and parietal abnormalities. Abstracts, Vol. 18* (p. 64). Paper presented at Society for Neuroscience 1992 annual meeting, Anaheim, CA.

Verbated, M. N., Roelfs, J. W., van Engeland, H., Kenemans, J. K., & Slangen, J. L. (1991). Abnormal visual event-related potentials of autistic children. *Journal of Autism and Developmental Disorders*, *21*, 449–470.

Volkmar, F., & Mayes, L. (1990). Gaze behaviour in autism. *Development and Psychopathology*, *2*, 61–69.

Wainwright-Sharp, J. A., & Bryson, S. E. (1993). Visual orienting deficits in high functioning people with autism. *Journal of Autism and Developmental Disorders*, *23*, 1–13.

World Health Organisation. (1993). *Mental disorders: A glossary and guide to their classification in accordance with the 10th Revision of the International Classification of Diseases (ICD-10)*. Geneva: Author.

Manuscript accepted 18 August 1997