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**AN EXPERIMENTAL INVESTIGATION OF SOCIAL-COGNITIVE  
ABILITIES IN INFANTS WITH AUTISM: CLINICAL IMPLICATIONS**

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Running head: Infants with autism.

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INFANTS WITH AUTISM: CLINICAL IMPLICATIONS

ABSTRACT

Competing theoretical accounts of psychopathological development in individuals with autism emphasize the role of different infant social, cognitive and affective factors, including affective responsivity, pretend play, joint attention and imitation. However, due to the fact that autism is rarely diagnosed before the age of three, until now these abilities have only been studied with school-age children, adolescents or young adults with autism. Taking advantage of a new prospective screening instrument for autism in infancy (Baron-Cohen et al., 1996), the present study compared the performance of 20 month old infants with autism and pervasive developmental disorder to that of children with developmental delay without autism on experimental tasks of empathic response, pretend and functional play, joint attention and requesting behaviors, and imitation. The 20 month old infants with autism failed to use social gaze declaratively in the joint attention task, they showed poor empathic response, fewer imitated modelled actions on objects, and none produced spontaneous pretend play. Surprisingly, the infants with pervasive developmental disorder did not perform significantly differently from the infants with developmental delay without autism on any of the measures. The identification of autism-specific impairments in early social cognitive abilities may have important clinical implications, both for the early diagnosis of the disorder and for the setting of goals and monitoring of progress in early intervention programmes.

## INTRODUCTION

Theoretical accounts of psychopathological development in individuals with autism emphasize the role of various social and cognitive factors that emerge during infancy in typical development. However, to date, research has mostly been conducted with school-age children, adolescents or young adults with autism (for a review, see Baron-Cohen, Tager-Flusberg & Cohen, 1993). This is because the disorder is rarely diagnosed before the age of 3 (Gillberg et al., 1990). Research with school-age children, adolescents and young adults with autism has demonstrated autism-specific impairments in a variety of infantile social-cognitive abilities, including empathic response (e.g. Sigman, Kasari, Kwon & Yirmiya, 1992), pretend play (e.g. Mundy, Sigman, Ungerer & Sherman, 1986; Wetherby & Prutting, 1984), joint attention behaviors (e.g. Baron-Cohen, 1989; Mundy et al., 1986) and imitation (e.g. Dawson & Adams, 1984; Rogers, Benetto, McEvoy & Pennington, 1996). These impairments have been cited as support for the theoretical accounts of psychopathological development put forward by various authors and, in turn, they have been linked to the later problems in social understanding and social communication that characterize autism (Baron-Cohen, 1993, 1995; Hobson, 1993; Leslie, 1987, 1994; Meltzoff & Gopnik, 1993; Mundy, 1995; Mundy, Sigman & Kasari, 1993; Rogers & Pennington, 1991).

To briefly summarize the research findings with older school-age children, adolescents and young adults with autism:

(1) Individuals with autism show poor coordination of affective response in that they are less likely than controls to combine smiles with eye contact and to smile in response to smiles from their mother (Dawson et al., 1990; Kasari et al., 1990), and are impaired in their empathic responses to signals of distress (Sigman et al., 1992).

(2) In unstructured or free-play conditions, children with autism produce significantly less pretend play, but intact functional play, compared to chronological or mental age-matched comparison groups (Baron-Cohen, 1987; Lewis & Boucher, 1988; Mundy et al., 1986; see Jarrold, Boucher & Smith, 1993, for a review).

(3) There is substantial experimental evidence for impairments in both the production and comprehension of joint attention behaviors in children with autism. Many studies have shown, for example, that while children with autism are able to use eye contact and gestures to request objects (protoimperative gestures) or to engage in social action routines, they nevertheless do not use eye contact and gestures to share interest in objects or their properties

(protodeclarative gestures) (e.g. Baron-Cohen, 1989; Mundy et al., 1986; see Charman, 1997, in press, for reviews).

(4) While most studies have demonstrated impaired imitation - in particular of complex and novel sequences of actions - in children with autism (Dawson & Adams, 1984; Rogers et al., 1996, see Smith & Bryson, 1994, for a review), a few studies have found that school-age children with autism are able to produce simple, basic-level imitation of gestures, actions on objects and facial expressions (e.g. Charman & Baron-Cohen, 1994; Loveland et al., 1994; Morgan et al., 1989).

The opportunity to study these social-cognitive abilities in younger children with autism would be of great clinical value, for several reasons: First, while it would be expected that infants with autism would demonstrate impaired development of empathy, pretend play, joint attention and imitation - since these have previously been found to be specifically impaired in older children, adolescents and adults with autism - information about the specificity of these impairments to autism in infancy (compared to infants with developmental delay without autism) would aid differential diagnosis between autism and other developmental and language delays in very young children. Secondly, early intervention programmes typically focus on increasing skills in the areas of functional and pretend play, imitation, and the understanding and production of joint attention gestural communication behaviors (Bondy & Frost, 1995; Rogers, 1996; Rogers & Lewis, 1989). Systematic measurement of which aspects of these skills are intact and which are impaired in infants with autism will inform the content and design of intervention programmes, and the development of sensitive outcome measures which would enable progress over time to be monitored.

In the present study, infants aged 20 months were tested on experimental measures of the following abilities: empathic response to a display of distress, spontaneous functional and pretend play, joint attention and requesting behaviors, and imitation. The present study is an advance on previous work in this area in a number of ways: First, the present research takes advantage of a recent prospective method of identification of autism (Baron-Cohen et al., 1996) to investigate the development of these social communicative abilities in infants with autism. Baron-Cohen, Allen and Gillberg (1992) developed a screening instrument for childhood autism (the CHecklist for Autism in Toddlers; CHAT). The CHAT checks for the presence of pretend play and joint attention behaviors, as well as unrelated developmental

accomplishments such as rough-and-tumble play. Studying a "high risk" sample of 18-month-old siblings of children already diagnosed as having autism, Baron-Cohen et al. (1992) found that only the four children who went on at age three to receive a diagnosis of autism failed both pretend play and joint attention at eighteen months. A similar screening method has been employed on a large population of 18-month-olds (see Baron-Cohen et al., 1996, for details). This enabled prospective identification of 8 infants with autism, 13 infants with atypical autism, Asperger's syndrome or pervasive developmental disorder, and 8 infants with developmental delays (primarily language delays) but without autism (see Baird et al., forthcoming, for details). Thus, we have been able to study a younger sample of individuals with autism than has previously been possible. Secondly, the present study compares the performance of infants with autism to those who show developmental impairments in the three recognized domains of autistic impairment of reciprocal social interaction, communication and repetitive and restrictive interests, but who do not meet the full diagnostic criteria for autism - but rather meet criteria for the related disorders of pervasive developmental disorder, Asperger's syndrome or atypical autism (ICD-10; WHO, 1993). While there is some disagreement about the nosological validity of the concept of an autistic continuum, or spectrum (Volkmar, 1997; Wing, 1988), information on whether and in what ways individuals with autism differ from those with atypical autism, Asperger's syndrome or pervasive developmental disorder in aspects of social-cognitive behavior in infancy and beyond will provide evidence against which the concept of a continuum with valid diagnostic subgroups can be judged. Thirdly, previous experimental work has largely adopted between-group comparisons to identify specific delays in these social-cognitive abilities in groups of individuals with autism, compared to groups of individuals with developmental delay without autism. This strategy can lead to the erroneous assumption that no individuals with autism show any of the behavior of concern at any particular age. Documenting the proportion of infants with autism, and those with related pervasive developmental disorders, who show some aspects of these behaviors, and comparing this to the proportion of infants with developmental delay without autism who show such behaviors, is an important database on which clinicians can draw when making decisions regarding differential diagnosis. Thus, since this is the first opportunity to study infants with autism, the findings of the present study represent important information at a descriptive level, as well as at the level of looking for between-group differences in the behaviors measured.

## METHOD

### Participants

The present research was part of the first epidemiological study to attempt early screening for autism. It employed the CHAT on a population of 16,000 18-month-old children (Baron-Cohen et al., 1996). The epidemiological aspects of the larger study are reported elsewhere (Baird et al., forthcoming; Baron-Cohen et al., 1996; Cox et al., 1997) and will not be considered here. Following identification of children considered at risk of developing autism according to their performance on the CHAT at 18 months - by failing items measuring the production and comprehension of protodeclarative pointing (pointing for interest), gaze monitoring, and the production of pretend play (see Baird et al., forthcoming; Baron-Cohen et al., 1996, for details) - the infants were tested on a series of experiments in the clinic at age 20 months. While tentative ICD-10 (WHO, 1993) diagnoses were made at this age, the children were followed up at age 42 months when full confirmatory ICD-10 diagnoses were made. The performance of participants in the present experiments at age 20 months is presented according to individuals' final diagnosis made at 42 months<sup>1</sup>.

Autism group: 8 children (7 boys, 1 girl) met ICD-10 (WHO, 1993) criteria for autism at age 42 months.

Pervasive Developmental Delay group: 13 children (11 boys, 2 girls) met ICD-10 criteria for atypical autism (2), Asperger's syndrome (2) or pervasive developmental delay (9) at age 42 months (hereafter know as the PDD group).

Developmental delay group: 8 children (3 boys, 5 girls)<sup>2</sup> met ICD-10 criteria for either expressive or mixed receptive-expressive language disorder, and of these 3 also had a non-verbal mental age 3 or more months below their chronological age (of approximately 20 months).

The descriptive data - chronological age (CA), non-verbal mental age (NVMA) measured by the A (motor development), D (eye-hand coordination) and E (performance) scales of the Griffiths Scale of Infant Development (Griffiths, 1986), and language ability measured by raw scores<sup>3</sup> on the Verbal Comprehension (VC) and Expressive Language (EL) subscales of the Reynell Language Scale (Reynell, 1985) - for the three participant groups is shown in Table 1. The groups were matched on all measures. Although there was a non-significant trend on the Reynell VC measure, with the autism group scoring lower than the other two groups (Analysis of variance: ANOVA;  $F(2,26) = 2.80$ ,  $p < .08$ ), post-hoc Scheffe

tests revealed that no two groups differed from each other at the  $p = .05$  significance level.

### The testing session

The experiments were conducted in a single session, and there was no fixed order of administering the tasks, except that the beginning of the testing sessions were invariant: the spontaneous play session was conducted first, in order to avoid spontaneous play being contaminated by the other tasks. Due to non-compliance not all children took part in all the trials. However, the drop-out was very low and is reported below for each individual task. The total testing time varied from child-to-child, but was usually between one-and-a-quarter hours and one-and-a-half hours. The sessions were videotaped and analyzed subsequently. The raters were blind to the diagnoses of the children. A subset of all tapes were rated by a second rater and inter-rater reliability calculated. Agreement was moderate to high, with kappa values between 0.75 and 1 for over three quarters of the variables coded, and on only 1 variable did kappa fall below 0.50 - pointing during the joint attention tasks (0.47) (see Charman et al., in press, for details).

Empathic response: A measure of affective and attentional response to a display of distress by an adult, based on earlier work by Sigman et al. (1992) and Zahn-Waxler, Robinson and Emde (1992), was employed. The experimenter (in all cases TC or JS) played jointly with the child, with a plastic pounding toy and hammer. During this, at a point when the child was actually touching the toy, the experimenter pretended to hurt himself by hitting his thumb with the hammer. For 10 seconds the experimenter displayed facial and vocal expressions of distress (i.e. cries of pain), without using words, and stopped touching the toy. After a further 10 second period of neutral affect the experimenter showed the child that their finger did not hurt any more, and resumed playing with the toy. Following the protocol employed by Sigman et al. (1992), it was recorded whether during the first 10 seconds of the trial the child: looked to the experimenter's face; looked to the experimenter's hand; and stopped playing with, or touching, the toy. In addition, the child's own facial affect was coded as either: (1) concerned/upset; (2) indifferent/neutral; or (3) positive.

Spontaneous play task: When the child entered the room the following sets of toys were available (all at once), spread out on the floor: a toy teaset; a toy kitchen stove with miniature pots and pans, spoon, pieces of green sponge; and junk accessories (e.g. brick, straw, rawplug, cottonwool, cube, box) and conventional toy accessories (toy animals, cars etc.). This combination of objects was based on the earlier studies by Baron-Cohen (1987)

and Lewis and Boucher (1988). The child's parents and the experimenters remained seated, and offered only minimal and non-specific responses to child-initiated approaches. Each child was filmed for 5 minutes. Each different play act produced by the child during the 5 minute session was coded into the following four mutually exclusive categories according to the definitions employed by Baron-Cohen (1987): sensorimotor; ordering; functional play; and pretend play. If there was uncertainty over which rating to make, the action was scored conservatively (i.e. the lower developmental categorization was scored: sensorimotor < functional < pretend; ordering play was not considered part of this hierarchy).

Joint attention tasks: A series of three active toy tasks based on those described by Butterworth and Adamson-Macedo (1987) were conducted. Although these tasks are similar to social referencing paradigms (e.g. Klinnert et al., 1986), social referencing behavior was not coded as the target variable was joint attention. The child stood or sat between their mother and the experimenter. A series of mechanical toys, designed to provoke an ambiguous response - that is, to provoke a mixture of attraction and uncertainty in the child - were placed one at a time onto the floor of the room 1 to 2 metres from the child. The toys were a robot, which flashed and beeped and moved around in circular sweeps; a car which followed a circular path around the room; and a pig which made "oinking" noises and shunted backwards and forwards. The toys were controlled by the experimenter via a control box and an electrical lead which ran from the box to the toy. They were active for a period of 1 minute, during which time they stopped and restarted twice. The following actions were scored as either present or absent for each trial: (1) infant switched gaze between toy and adult (experimenter or parent) and back to toy, (2) infant looked to control box, (3) infant pointed to target object, (4) infant reached towards target object, and (5) infant vocalized.

Goal detection tasks: A series of task described by Phillips et al. (1992) were conducted at different times throughout the testing session: (1) The blocking task: When the child was manually and visually engaged with a toy, the experimenter covered the child's hands with his own, preventing the child from further activity, and held the block for 5 seconds. This was repeated 4 times during the session. (2) The teasing task: The experimenter offered the child a toy. When the child looked at the toy and began to reach for out it, the experimenter withdrew the toy and held it out of reach for 5 seconds. The experimenter then gave the toy to the child. This was repeated 4 times during the session. The key behavior recorded on each trial was whether the child looked up towards the



experimenter's eyes during the 5 second period immediately after the block or the tease. While in previous studies we have regarded a look to the experimenter's face following the ambiguous blocking or teasing action to indicate a declarative gesture on the part of the infant (Phillips et al., 1992; Charman et al., in press), we are now persuaded by the argument that they in fact may be measuring a form of imperative, or requesting, gesture - since the look to the experimenter when an object is held out and then removed may well have an instrumental function ("give me that back") (Peter Mundy, personal communication; see Charman, in press, for discussion).

Imitation: The materials and method for the procedural imitation task followed those employed with normally-developing infants by Meltzoff (1988), and employed with older subjects with autism by Charman and Baron-Cohen (1994). The child sat opposite the experimenter. Four actions were modelled, all on objects designed to be unfamiliar to the child. Each act was performed 3 times. At the end of the modelling period (about 2 minutes in all), the objects were placed, in turn, in front of the child. One non-specific prompt ("What can you do with this?") was given if the child failed to pick up or manipulate the object at once. The response period was 20 seconds, for each object. Rigorous scoring criteria for imitation of each action, as set out by Meltzoff (1988), were adopted.

## RESULTS

Empathic response task: All subjects took part in this task. The results are summarized in Table 2. While all 8 infants with developmental delay and all but two of the infants with PDD looked to the experimenter's face, only half of the infants with autism did so ( $X^2(2, N = 29) = 6.50, p < .04$ ). The post-hoc group-by-group comparison reached significance between the autism and developmental delay groups (post-hoc Fisher's exact test;  $p < .04$ ), but failed to reach statistical significance for autism vs. PDD comparison. Only one infant with autism showed facial concern at the feigned distress, compared to nearly half the infants with PDD and developmental delay, although this comparison did not reach significance ( $X^2(2, N = 29) = 2.53, p = ns$ ). There were no significant differences in the proportion of infants in each group who looked to the experimenter's "injured" hand, nor in those who continued to touch the toy, although fewer infants with autism looked to the experimenter's "injured" hand and all but one continued to touch the toy - compared to approximately half of the infants in the PDD and developmental delay groups.

Spontaneous play task: One infant from the PDD group did not take part in this task.

The percentage of children in each group producing at least one example of play in each of the four categories - sensorimotor, ordering, functional and pretend - is shown in Table 3. All participants across all three groups produced some examples of sensorimotor play, with very few subjects showing ordering play. Over half the infants in all three groups produced some functional play acts. However, no infants in the autism group and only 3 in the PDD group produced any examples of pretend play, compared to half the infants in the developmental delay group - a trend which did not reach statistical significance ( $X^2(2, N = 28) = 5.33, p < .10$ ). However, post-hoc group-by-group comparison reached significance for the autism versus developmental delay group comparison (post-hoc Fisher's exact test; autism x PDD = ns; autism x developmental delay  $p < .04$ ; PDD x developmental delay  $p = ns$ ).

Joint attention tasks: The groups of participants with autism, PDD and developmental delay completed a mean of 2.6, 2.7 and 2.8 out of 3 possible trials, respectively. The percentage of completed trials on which the infants produced the key behaviors are shown in Table 4. The data was analyzed in two ways: First the group mean proportion of trials on which the critical behavior was observed was analysed by analysis of covariance (ANCOVA), with chronological age (CA) and non-verbal mental age (NVMA) entered as covariates. Secondly, the proportion of participants who produced at least one example of each behavior across the trials completed was analysed non-parametrically using the chi-square test. On the critical declarative joint attention behavior of gaze switch between the toy and an adult, infants with PDD and developmental delay produced gaze switches on approximately two thirds of trials, compared to only approximately one quarter of trials for the infants with autism. This comparison produced a significant main effect for group (ANCOVA;  $F(2,24) = 3.89, p < .04$ ), and no covariate effects. Post-hoc group-by-group ANCOVA comparisons revealed that infants with autism gaze switched less than the infants from both the PDD and the developmental delay groups (ANCOVA;  $F(1,17) = 6.46, p < .03$ ; and ANCOVA;  $F(1,12) = 5.39, p < .04$ ; respectively). All but three of the infants with PDD and all but one of the infants with developmental delay produced at least one gaze switch, compared to only 3 of the infants with autism, although this trend just missed statistical significance ( $X^2(2, N = 29) = 5.37, p < .07$ ). Across all three groups, participants looked to the box which controlled the mechanical toys on between one third and one half of trials. Across all three groups, participants pointed and reached towards the toy, and produced vocalizations, on relatively few trials and across these variables, there were no significant

differences between the groups.

Goal detection tasks: The groups of participants with autism, PDD and developmental delay completed a mean of 3.6, 3.8 and 3.8 out of 4 possible blocking trials, and 3.3, 3.1 and 3.5 out of a possible 4 teasing trials, respectively. The mean percentage (standard deviation in brackets) of completed blocking trials on which the infants looked to the experimenter's face (taken to indicate an imperative or requesting gesture) was 20% ( $sd = 35\%$ ) in the autism group, 56% ( $sd = 44\%$ ) in the PDD group, and 62% ( $sd = 44\%$ ) in the developmental delay group. On the teasing trials the mean ( $sd$ ) percentages were 13% (19%), 52% (50%), and 53% (39%), respectively. However, despite the fact that infants with autism looked to the experimenter on fewer trials than the infants in the two other groups, there were no significant main group effects on either the blocking or the teasing trials, and no covariate effects (ANCOVA,  $F(2,24) = 1.76$ ,  $p = ns$ ; and ANCOVA,  $F(2,24) = 2.52$ ,  $p = ns$ ; respectively). Similarly, when analysed in terms of the proportion of participants in each group who produced a look to the experimenter on at least one trial there were no significant group differences on either task, with 38% of the infants with autism, 77% of the infants with PDD, and 75% of the infants with developmental delay producing at least one look on the blocking trials, and 38%, 62% and 75% in the teasing trials, respectively (both  $X^2(2, N = 29)$ ,  $p > .10$ ).

Imitation task: The groups of participants with autism, PDD and developmental delay completed a mean of 3.9, 4.0 and 3.4 out of 4 possible imitation trials, respectively. The mean percentage of imitation trials on which the infants successfully imitated the modelled actions were 22% ( $sd = 25\%$ ) in the autism group, 56% ( $sd = 34\%$ ) in the PDD group, and 65% ( $sd = 26\%$ ) in the developmental delay group. This comparison produced a significant main effect for group (ANCOVA;  $F(2,24) = 3.47$ ,  $p < .05$ ), and no covariate effects. Post-hoc group-by-group ANCOVA comparisons revealed that infants with autism gaze switched less than the infants from both the PDD and the developmental delay groups (ANCOVA;  $F(1,17) = 5.27$ ,  $p < .04$ ; and ANCOVA;  $F(1,12) = 8.32$ ,  $p < .02$ ; respectively). When analysed non-parametrically, in terms of the proportion of participants in each group who produced at least one imitative action, there was also a significance difference, with only 50% of the infants with autism producing at least one imitative action, compared to 85% of the infants with PDD, and 100% of the infants with developmental delay ( $X^2(2, N = 29) = 6.50$ ,  $p < .04$ ). The post-hoc group-by-group comparison reached significance between the autism and

developmental delay groups (post-hoc Fisher's exact test;  $p < .04$ ) but failed to reach statistical significance for autism vs. PDD comparison (post-hoc Fisher's exact test;  $p = ns$ ).

## DISCUSSION

As indicated in the introduction, the strategy employed to analyse the present dataset took into account analysis of between-group differences and the absolute level of performance of individual subjects within each group. This dual strategy is important in terms of providing some database against which clinical decisions can be made regarding the significance of the presence, or absence, of one particular behavior in any individual infant on similar experimental measures conducted in the clinic. Such useful descriptive information can easily be masked by adopting a between-group analytical strategy only, which can lead to an incorrect impression that all individuals with autism do not produce any examples of certain behaviors, because their group mean is significantly less than that of a comparison group. Thus, throughout this discussion both differences between the groups, and the degree of variability in performance of the behavior of concern within any particular diagnostic group, will be considered.

Across the different aspects of social-cognitive development measured, the group of infants with autism showed very low production of some behaviors, in contrast to the infants with PDD and developmental delay. For instance, only half the infants with autism looked at the experimenter during their feigned distress in the empathy task and only one was rated as showing facial concern. Thus, while some individuals with autism noticed the cry of distress, only one showed any clear evidence of an empathic response (Sigman et al., 1992; Zahn-Waxler et al., 1992). This is in contrast to the infants with PDD and developmental delay, nearly all of whom noticed the "distress" and half of these showed active facial concern.

Similarly, while all but three of the infants with PDD and one infant with developmental delay produced at least one example of a gaze switch of visual attention in response to ambiguous toys on the joint attention task - and did so consistently with gaze switches occurring on nearly two thirds of trials in both groups - only one third of the infants with autism produced even one example of a gaze switch. In contrast, they produced as many "non-social" looks at the box that controlled the toys. Thus, it seems clear that the infants with autism were interested in the mechanical toys (indeed all children looked intently at the ambiguous toys), and were able to use gaze to investigate physical aspects of the paradigm (by looking to the control box through which the experimenter stopped and started the toy),

but did not use gaze to share aspects of the situation with an adult, in contrast to both the PDD and developmental delay infants. This concurs with previous experimental findings that difficulties in the declarative aspects of the eye gaze behavior, particularly when it involves the triadic switching of attention from person to object and back to person, is one of the most pronounced social communicative impairments in individuals with autism (e.g. Baron-Cohen, 1989; Mundy et al., 1986; see Charman, 1997, in press; Mundy et al., 1993 Mundy, 1995, for reviews).

A similar pattern also emerged on the imitation task, with the infants with autism imitating on only one fifth of the trials, in contrast to infants with PDD and developmental delay who imitated on over half the trials. While this contrasts with a recent study with school-age children with autism using the same tasks which found no autism-specific deficit (Charman & Baron-Cohen, 1994), it is in line with majority of studies that find impairments in imitation in autism (see Rogers et al., 1996; Smith & Bryson, 1994, for reviews), and it suggests that while some simple, basic-level imitation abilities may present by school-age in children with autism, they are not in place by age 20 months.

In contrast to this, on the goal-detection tasks - taken as measures of imperative or requesting behavior - one third of the infants with autism looked to the experimenter following the ambiguous action on at least one trial. Thus, while as a group the individuals with PDD and developmental delay produced more than twice as many looks to the experimenter as the individuals with autism across all the trials completed, these differences did not reach statistical significance because at least some of the infants with autism were producing some imperative looks on at least some trials.

A different pattern of results was found on the spontaneous play task. Here no infants with autism and only 3 with PDD produced any examples of pretend play, in contrast to half the infants with developmental delay. However, two-thirds of subjects in all three groups produced some examples of functional play. These findings are similar to the majority of studies that have previously looked at spontaneous pretend play in autism (Baron-Cohen, 1987; Lewis & Boucher, 1988; Mundy et al., 1986; see Jarrold et al., 1993, for a review).

While the poor performance of the infants with autism was expected - indeed in all cases older samples had been previously shown to be impaired on similar tasks - more surprising was the intact performance of the PDD group on the empathy, joint attention, goal-detection and imitation tasks. Their performance was very close to that of the infants with

developmental delay without an autism spectrum diagnosis on all tasks, with the exception of spontaneous pretend play. While very little experimental data is available that pertains to differences between individuals with autism and PDD on such measures, we expected that the individuals with PDD would perform similarly to the individuals with autism - or at least somewhere between the individuals with autism and those with developmental delay without autism. Since the most recent revisions of the two classification systems employed in international research - ICD-10 (WHO, 1993) and DSM-IV (APA, 1994) - clarified the status of individuals who meet most, but not the full, diagnostic criteria for autism, researchers are increasingly dividing participants who fall onto the autistic continuum into those with "core" autism versus those with related PDDs. Further research will confirm whether our unexpected finding - that infants with PDD performed more similarly to infants with developmental delay without autism than to infants with autism - is replicable.

This highlights one important caution in the interpretation of these experimental findings - while the performance of the infants with PDD was very similar to that of the infants with developmental delay in these structured experimental measures conducted at 20 months, their observed and reported behavior in the full clinical assessments conducted at age 42 months (on the basis of which ICD-10 clinical diagnoses and assignment to experimental groups was made) did distinguish the groups. From the present data we are unable to conclude whether this represents some change in the behavior shown by the infants with PDD between 20 months and 42 months when the final clinical diagnosis was made (see Baird et al., forthcoming; Cox et al., 1997, for discussion), or whether it reflects a discrepancy between everyday interactions and performance on such structured experimental tasks. We are currently analysing data from structured interactions with the present sample collected at age 20 months and 42 months, in order to help answer this question. One clear caution is warranted - isolated examples of pretend play, gaze switching and imitative behavior in clinical diagnostic assessments of infants or preschool children cannot rule out a diagnosis of PDD - nor indeed of autism, since many individuals with PDD and, a few individuals with autism, did produce examples of all the target social communication behaviors (with the exception of spontaneous pretend play).

The present findings are also of relevance to theoretical accounts of the psychopathological development in autism. Studying the pattern of intact abilities and impairments shown by infants with autism and PDD in these early-emerging social-

communicative abilities may contribute to the delineation of which early social-communication behaviors are functionally related to later-emerging skills, such as theory of mind development, which previous research has demonstrated are impaired in school-age children with autism (see, Baron-Cohen, 1993; for a review). This will have implications for our understanding of the abnormal development of social communication in autism, and further our understanding of the developmental trajectories of empathy, play, joint attention and imitation in the normal case. However, the theoretical conclusions that can be drawn from the present cross-sectional study alone are limited, and we must await the outcome of longitudinal and training studies (Bradley & Bryant, 1983) in order to better understand the relationship between impairments in the early social communicative abilities studied here and the characteristic pattern of social-communicative impairments seen in school-age children with autism.

To return to the present focus on the clinical utility of studying infants with autism: the present results could help inform the content and strategy of intervention programmes. For example, the fact that some infants with autism are able to produce functional play is an important consideration when designing an intervention programme with a play element, which aims to increase the repertoire of symbolic play activity in which the child can engage. Reinforcement and shaping of the functional use of objects, and the introduction of similar- and near-shaped non-functional objects into the play routine (Jarrod, Boucher & Smith, 1996), might increase the development of truly symbolic, or pretend, play. Similarly, the fact that half the infants with autism noticed the experimenter's feigned cries of distress - while only one actually showed any affective empathic response - is a starting point for teaching and shaping behavioral responses to the emotional displays of others. It may be that more basic deficits in conceptual or affective ability in individual's with autism will eventually undermine such enterprises, but research evidence is beginning to emerge that early intervention programmes that take such a step-by-step to the development of social communication skills can bear significant benefit over time (Bondy & Frost, 1995; Rogers & Lewis, 1989; see Rogers, 1996, for a review). The fact that some 20 month old infants with autism were found to have some intact social communication behaviors in the domains of empathy, joint attention, pretend play, and imitation studied, and further that many of those who did not showed some (perhaps earlier emerging) related behaviors - such as functional play, noticing distress, imperative requests - gives a starting point for intervention

programmes with even the youngest children seen in child development clinics for autism. Experimental measures that are quick to conduct and that can be given in a relatively standardized and repeated manner (with different materials in some cases where learning might be expected to occur over repeated presentations e.g. in the imitation task), such as those used in the present study, have the potential to be used to monitor the progress of individuals in intervention studies.

The opportunity to study this unique sample of infants with autism and PDD has given us the opportunity to document their profile of infantile social cognitive abilities around the time that these abilities emerge - rather than years later as is the case with much research into autism. We hope to fill out this developmental account of autism by following the sample into their preschool and school-age years, and then may be able to answer with more certainty questions about the typical development of social cognitive abilities in infancy, their relationship to later social cognitive abilities, and the atypical course of this developmental trajectory in individuals with autism and related disorders.



## FOOTNOTES

1. Portions of these data have been presented in a previous paper (Charman et al., in press). However, when this earlier paper was written only the diagnoses of autism made at 20 months had been confirmed at age 42 months. Further, in Charman et al. (in press) data are not presented separately on children who do not meet ICD-10 criteria for core autism but rather meet criteria for atypical autism, Asperger's syndrome or pervasive developmental disorder. In the present study, all children had been followed up at age 42 months and ICD-10 (WHO, 1993) diagnoses had been made at this age. See Baird et al. (forthcoming) and Cox et al. (1997) for discussion of the stability of diagnosis between 20 months and 42 months.
2. Although the groups were not matched for gender, and as would be expected the majority of participants in the autism and PDD groups were male, analysis of the performance of boys and girls in the developmental delay group revealed no differences and data are presented for all participants seen.
3. Raw scores were used since some subjects scored below the floor for assigning a language age equivalent.

## REFERENCES

- American Psychiatric Association (1994) Diagnostic and Statistical Manual of Mental Disorders. (4th Edn.) (DSM-IV) Washington, DC: American Psychiatric Association.
- Baird, G., Cox, A. Baron-Cohen, S., Swettenham, J., Charman, T., Drew, A. & Nightingale, N. (forthcoming) What are the rates of false positives and negatives in detecting autism at 18 months of age using the CHAT? Unpublished manuscript. University of London.
- Baron-Cohen, S. (1987) Autism and symbolic play. British Journal of Developmental Psychology, 5, 139-148.
- Baron-Cohen, S. (1989) Perceptual role-taking and protodeclarative pointing in autism. British Journal of Developmental Psychology, 7, 113-127.
- Baron-Cohen, S. (1993) From attention-goal psychology to belief-desire psychology: the development of a theory of mind and its dysfunction. In Baron-Cohen, S., Tager-Flusberg, H. & Cohen, D. (Eds.) Understanding other minds: perspectives from autism (pp. 59-82). Oxford University Press.
- Baron-Cohen, S. (1995) Mindblindness: an essay on autism and theory of mind. Massachusetts: MIT Press.
- Baron-Cohen, S., Allen, J & Gillberg, C. (1992) Can autism be detected at 18 months? The needle, the haystack and the CHAT. British Journal of Psychiatry, 161, 839-842.
- Baron-Cohen, S., Tager-Flusberg, H. & Cohen, D. (1993) Understanding other minds: perspectives from autism. Oxford: Oxford University Press.
- Baron-Cohen, S., Cox, A., Baird, G., Swettenham, J., 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.
- Bondy, A. S. & Frost, L. A. (1995) Educational approaches in preschool: Behavior techniques in a public school setting. In E. Schopler & G. B. Mesibov (Eds.) Learning and Cognition in Autism. (pp. 311-333) New York: Plenum.
- Bradley, L. & Bryant, P. E. (1983) Categorizing sounds and learning to read - a causal connection. Nature, 301, 419-421.
- Butterworth, G. (1991) The ontogeny and phylogeny of joint visual attention. In A. Whiten (Ed.) Natural theories of mind. Oxford: Basil Blackwell.
- Butterworth, G.E. & Adamson-Macedo, E. (1987) The origins of pointing: a pilot study.

Paper presented at the Annual Conference of the Developmental Psychology Section of the British Psychological Society. September 1987, York, UK.

- Charman, T. (1997) The relationship between joint attention and pretend play in autism. Development and Psychopathology, 9, 1-16.
- Charman, T. (in press) Specifying the nature and course of the joint attention impairment in autism in the preschool years: implications for diagnosis and intervention. Autism: The International Journal of Research and Practice.
- Charman, T. & Baron-Cohen, S. (1994) Another look at imitation in autism. Development and Psychopathology, 6, 403-413.
- Charman, T., Swettenham, J., Baron-Cohen, S., Cox, A., Baird, G. & Drew, A. (in press) Infants with autism: an investigation of empathy, pretend play, joint attention and imitation. Developmental Psychology.
- Cohen, J. (1960) A coefficient of agreement for nominal scales. Educational and Psychological Measurement, 20, 37-46.
- Cox, A., Klein, K., Charman, T., Baird, G., Baron-Cohen, S., Swettenham, J., Wheelwright, S. & Drew, A. (forthcoming) What is the primary abnormality in autism? Evidence from the ADI-R at 20 months and 42 months. Paper presented at the Biennial Conference of the Society for Research in Child Development. April 1997, Washington DC.
- Dawson, G., Hill, D., Spencer, A., Galpert, L. & Watson, L. (1990) Affective exchanges between young autistic children and their mothers. Journal of Abnormal Child Psychology, 18, 335-345.
- Dawson, G. & Adams, A. (1984) Imitation and social responsiveness in autistic children. Journal of Abnormal Child Psychology, 12, 209-226.
- Gillberg, C., Ehlers, S., Schaumann, H., Jakobsson, G., Dahlgren, S. O., Lindblom, R., Bagenholm, A., Tjuus, T. & Blinder, E. (1990) Autism under age 3 years: a clinical study of 28 cases referred for autistic symptoms in infancy. Journal of Child Psychology and Psychiatry, 31, 921-934.
- Griffiths, R. (1986) The abilities of babies. London: University of London Press.
- Hobson, R. P. (1993) Autism and the development of mind. London: Lawrence Erlbaum.
- Jarrold, C. Boucher, J. & Smith, P. (1993) Symbolic play in autism: a review. Journal of Autism and Developmental Disorders, 23, 281-308.

- Jarrold, C., Boucher, J. & Smith, P. (1996) Generativity deficits in pretend play in autism. British Journal of Developmental Psychology, *14*, 275-300.
- Kasari, C., Sigman, M., Mundy, P. & Yirmiya, N. (1990) Affective sharing in the context of joint attention interactions of normal, autistic and mentally-retarded children. Journal of Autism and Developmental Disorders, *20*, 87-100.
- Klennert, M. D., Emde, R. N., Butterfield, P. & Campos, J. J. (1986) Social referencing: the infant's use of emotional signals from a friendly adult with mother present. Developmental Psychology, *22*, 427-432.
- Leslie, A.M. (1987) Pretence and representation: the origins of "theory of mind". Psychological Review, *94*, 412-426.
- Leslie, A. M. (1994) Pretending and believing: issues in the theory of ToMM. Cognition, *50*, 211-238.
- Lewis, V. & Boucher, J. (1988) Spontaneous, instructed and elicited play in relatively able autistic children. British Journal of Developmental Psychology, *6*, 325-339.
- Loveland, K., Tunali-Kotoski, B., Pearson, D. A., Brelsford, K. A., Ortegon, J. & Chen, R. (1994) Imitation and expression of facial affect in autism. Development and Psychopathology, *6*, 433-443.
- Meltzoff, A. N. (1988) Infant imitation and memory: nine-month-olds in immediate and deferred tests. Child Development, *59*, 217-225.
- Meltzoff, A. N. & Gopnik, A. (1993) The role of imitation in understanding persons and developing theories of mind. In S. Baron-Cohen, H. Tager-Flusberg & D. Cohen (Eds.) Understanding Other Minds: Perspectives from Autism. (pp. 335-366) Oxford: Oxford University Press.
- Morgan, S. B., Cutrer, P. S., Coplin, J. W. & Rodrigue, J. R. (1989) Do autistic children differ from retarded and normal children in Piagetian sensorimotor functioning? Journal of Child Psychology and Psychiatry, *30*, 857-864.
- Mundy, P. (1995) Joint attention and social-emotional approach behavior in children with autism. Development and Psychopathology, *7*, 63-82.
- Mundy, P., Sigman, M., Ungerer, J. A. & Sherman, T. (1986) Defining the social deficits of autism: the contribution of non-verbal communication measures. Journal of Child Psychology and Psychiatry, *27*, 657-669.
- Mundy, P., Sigman, M. & Kasari, C. (1993) The theory of mind and joint attention in

- autism. In S. Baron-Cohen, H. Tager-Flusberg & D. Cohen (Eds.) Understanding Other Minds: Perspectives from Autism (pp. 181-204). Oxford: Oxford University Press.
- Phillips, W., Baron-Cohen, S. & Rutter, M. (1992) The role of eye-contact in goal-detection: evidence from normal toddlers and children with autism or mental handicap. Development and Psychopathology, *4*, 375-384.
- Reynell, J. K. (1985) Reynell Developmental Language Scales (2nd Edn.). Windsor: NFER Nelson.
- Rogers, S. J. & Pennington, B. F. (1991) A theoretical approach to the deficits in infantile autism. Development and Psychopathology, *3*, 137-162.
- Rogers, S. J., Benetto, L., McEvoy, R. & Pennington, B. F. (1996) Imitation and pantomime in high-functioning adolescents with autism spectrum disorders. Child Development, *67*, 2060-2073.
- Rogers, S. J. (1996) Brief report: Early intervention in autism. Journal of Autism and Developmental Disorders, *26*, 243-246.
- Rogers, S. J. & Lewis, H. (1989) An effective day treatment model for young children with pervasive developmental disorders. Journal of the American Academy of Child and Adolescent Psychiatry, *28*, 207-214.
- Sigman, M. D., Kasari, C., Kwon, J. H. & Yirmiya, N. (1992) Responses to the negative emotions of others by autistic, mentally retarded, and normal children. Child Development, *63*, 796-807.
- Smith, I. M. & Bryson, S. E. (1994) Imitation and action in autism: a critical review. Psychological Bulletin, *116*, 259-273.
- Volkmar, F. (1997) Ask the Editor. Journal of Autism and Developmental Disorders, *27*, 103-105.
- Wetherby, A. M. & Prutting, C. A. (1984) Profiles of communicative and cognitive-social abilities in autistic children. Journal of Speech and Hearing Research, *27*, 364-377.
- Wing, L. (1988) The continuum of autistic characteristics. In E. Schopler & G. B. Mesibov (Eds.) Diagnosis and assessment in autism. New York: Plenum.
- 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: W.H.O.

Zahn-Waxler, C., Robinson, J. L. & Emde, R. N. (1992) The development of empathy in twins. Developmental Psychology, 28, 1038-1047.

Table 1 Chronological age (CA) and Griffiths non-verbal mental age (NVMA) in months, and raw Reynell verbal comprehension (VC) and expressive language (EL) scores for the autism, pervasive developmental delay (PDD) and developmental delay groups.

	Autism	PDD	Developmental delay
	<u>mean</u> <u>sd</u>	<u>mean</u> <u>sd</u>	<u>mean</u> <u>sd</u>
	(N = 8)	(N = 13)	(N = 8)
CA	21.4 (1.8)	20.5 (1.7)	20.5 (1.0)
NVMA	17.5 (1.9)	17.5 (1.6)	18.3 (2.0)
VC	3.1 (1.1)	6.4 (3.8)	6.9 (3.7)
EL	6.1 (2.8)	8.4 (3.8)	9.4 (1.1)

Table 2 Percent of children in the autism, pervasive developmental delay (PDD) and developmental delay groups who produced the key behaviors on the empathy task.

		Look face	Look hand	Continue to touch toy	Show facial concern
Autism	(N = 8)50%	25%	88%	13%	
PDD	(N = 13)	85%	62%	46%	46%
Developmental delay	(N = 8)100%*	38%	50%	38%	

\*  $p < .05$



Table 3 Percentage of children in the autism, pervasive developmental delay (PDD) and developmental delay groups who produced each category of play in the spontaneous play task.

		Sensori- motor	Ordering	Functional	Pretend
Autism	(N = 8)100%	25%	63%	0%	
PDD	(N = 12)	100%	0%	92%	25%
Developmental delay	(N = 8)	100%	25%	63%	50%

Table 4 Percentage of trials on which children in the autism, pervasive developmental delay (PDD) and developmental delay groups produced the key behaviors on the joint attention task.

	Look to adult <u>mean</u> <u>sd</u>	Look to box <u>mean</u> <u>sd</u>	Point <u>mean</u> <u>sd</u>	Reach <u>mean</u> <u>sd</u>	Vocalise <u>mean</u> <u>sd</u>
Autism (N = 8)	23% (37%)	33% (31%)	0% (-) 4% (12%)	4% (12%)	
PDD (N = 13)	64% (44%)	53% (35%)	18% (32%)	28% (40%)	26% (27%)
Develop. (N = 8) delay	71% (38%)*	54% (43%)	6% (18%)	8% (15%)	17% (36%)

\*  $p < .05$