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

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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 3, 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 emphatic 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, for the early diagnosis of the disorder and for the setting of goals and monitoring of progress in early intervention programs.

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RESUMEN: Las teorías que tratan de explicar el desarrollo sicopatológico en los individuos con autismo enfatizan el papel de diferentes factores sociales, cognitivos y afectivos en el infante, incluyendo obediencia afectiva, juego pretendido, atención conjunta e imitación. Sin embargo, debido al caso de que el autismo es muy raramente diagnosticado antes de los tres años, hasta ahora estas habilidades han sido estudiadas solamente con niños de edad escolar, adolescentes o jóvenes adultos con autismo. Sacando provecho de un nuevo posible instrumento de investigación para el autismo infantil (Baron-Cohen et al., 1996), el presente estudio comparó la actuación de infantes de 20 meses que padecían de autismo y trastornos de desarrollo que se difunden con la actuación de niños con retardo en el desarrollo pero sin autismo, sobre la base de tareas experimentales de respuesta enfática, juego pretendido y funcional, atención conjunta y conductas requeridas, y la imitación. Los infantes de 20 meses con autismo fallaron en el uso de la mirada fija declarativamente en la tarea de atención conjunta, mostraron una pobre respuesta enfática, menos acciones imitadas modeladas sobre objetos, y ninguno produjo un juego pretendido espontáneo. Sorprendentemente, los infantes con trastornos de desarrollo que se difunden no actuaron significativamente diferente de aquellos infantes con retardo en el desarrollo y sin autismo, en ninguna de las medidas. La identificación de impedimentos de autismo específicos en las tempranas habilidades sociales cognitivas pudiera tener importantes implicaciones clínicas, tanto para el diagnóstico temprano del trastorno, como para el establecimiento de metas y la supervisión del progreso en los programas de una temprana intervención.

RÉSUMÉ: Des comptes rendus théoriques rivaux de développement psychopathologique chez des individus atteins d'autisme mettent en valeur le rôle de différents facteurs infantiles sociaux, cognitifs et affectifs, y compris la réponse affective, les jeux à faire semblant, l'attention commune et l'imitation. Cependant, à cause du fait que l'autisme est rarement diagnostiqué avant l'âge de trois ans, jusqu'à présent ces capacités n'ont été étudiées qu'avec des enfants d'âge scolaire, des adolescents ou des jeunes adultes atteints d'autisme. Bénéficiant du nouvel instrument de dépistage d'autisme chez la petite enfance (Baron-Cohen et al, 1996), cette étude a comparé la performance de bébés de 20 mois atteints d'autisme et de troubles du développement généralisés à celle d'enfant ayant des retards de développement sans autisme sur des exercices expérimentaux de réponse empathique, des jeux à faire semblant et des jeux fonctionnels, une attention commune et des comportements de demande, et l'imitation. Les bébés de 20 mois atteints d'autisme n'ont pas utilisé de regard social pendant un exercice d'attention commune. Ils firent preuve d'une réponse empathique diminuée, de moins d'actions modelées et imitées sur des objets. Et aucun d'entre eux n'a spontanément joué à faire semblant. De façon surprenante, les bébés ayant des troubles du développement généralisés n'ont pas réussi différemment des enfants ayant un retard du développement sans autisme, et cela sur aucune des mesures. L'identification de retards spécifiques à l'autisme dans les compétences précoces sociales et cognitives peuvent avoir d'importantes implications cliniques, à la fois pour le diagnostique précoce du trouble et lorsqu'il s'agit de se donner des buts et de surveiller les progrès dans des programmes d'intervention précoce.

ZUSAMMENFASSUNG: Theoretische Schriften zur psychopathologischen Entwicklung bei Autisten betonen die Rolle unterschiedlicher soziale, kognitiver und affektiver Faktoren, die etwa die gefühlsmäßige Einstimmung, das Rollenspiel und die geteilte Aufmerksamkeit und Nachahmung, beinhalten. Auf Grund der Tatsache, daß Autismus nur selten vor dem 3. Lebensjahr diagnostiziert wird, gibt es nur Studien mit Schulkindern, Adoleszenten, oder jungen Erwachsenen, die an Autismus leiden. Wir haben von einem neuen, prospektiv einsetzbaren Suchtest für Autismus der Kleinkindzeit Gebrauch gemacht (Baron-Cohen et al, 1996) und präsentieren in dieser Studie das Können von zwanzigmonatigen Kleinkindern mit Autismus und tiefergreifenden Entwicklungsstörungen, die wir mit entwicklungsverzögerten Kindern, die nicht an Autismus leiden, vergleichen. Wir verwandeten dazu experimentelle Aufgaben der einfühlsamen Reaktion, Rollenspiel und funktionelles Spiel, geteilte Aufmerksamkeit und Äußerung von Bedürfnissen und Nachahmung. Die zwanzigmonatigen Kleinkinder mit Autismus konnten keinen Blickkontakt bei der geteilten Aufmerksamkeit verwenden, sie zeigten eine geringere Einfühlung, nur wenige imitierten vorgezeigtes Umgehen mit Dingen, und keines zeigte spontanes Rollenspiel. Zu unserer Überraschung zeigte die Gruppe der Kleinkinder mit einer tiefergreifenden. Entwicklungastörung keine signifikanten Unterschiede bei irgendeiner Maßzahl zu der Gruppe der entwicklungsverzögerten Kinder ohne Autismus.

Die Feststellung von autismus-spezifischen Behinderungen bei frühen sozial-kognitiven Fähigkeiten könnte wichtige klinische Bedeutung haben, sowohl für die Frühdiagnose der Störung, als auch für die Bestimmung der Therapieziele und der Einschätzung des Verlaufs bei Frühinterventionsprogrammen.

抄録：自閉症児の精神病理的発達を説明する理論には競合するものがいくつかあるが、それぞれの理論的説明は、情緒的反応性、ごっこ遊び、共同注意、模倣など、それぞれに異なった乳児の社会的、認知的、情動的要素の役割を強調する。しかしながら、自閉症の診断は 3歳まで稀であるため、そうした能力に関する研究は、つい最近まで、自閉症がある学齢児、思春期児と、青年に限られていた。この研究は、乳幼児自閉症の、新しいプロスペクティブなスクリーン法(Baron-Cohen et al., 1996)を用い、自閉症か広汎性発達障害がある20カ月乳児と、発達の遅れはあるが自閉症はない乳児とを比べた。比較した作業内容は、共感的反応、ごっこ遊びと機能遊び、共同注意と懇願行動、模倣である。自閉症がある20カ月乳児は、共同注意作業において社会的凝視を陳述として使えず、共感的反応に乏しく、対象を真似た模倣活動が少なく、一人として自発的なごっこ遊びを始めなかった。これらの項目の測定値をもとにする限り、驚いた事に、広汎性発達障害がある乳児と発達の遅れはあるが自閉症はない乳児との間に有意の差は見られなかった。自閉症特異的な損傷を早期認知的能力に同定することは、障害の早期診断、そして、早期介入プログラムの目標設定と経過モニターの両方にとって、重要な臨床的意味合いを持っている。

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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 summarize briefly 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 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, 1998, 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, Cutrer, Coplin, & Rodrigue, 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—because 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. Second, early intervention programs 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 programs, 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 3 to receive a diagnosis of autism failed *both* pretend play and joint attention at 18 months. A similar screening method has been used 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. Second, 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 not otherwise specified, 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. Third, 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, because 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 used 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.[1] 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 not otherwise specified (9) at age 42 months (hereafter know as the PDD group). Developmental delay group: 8 children (3 boys, 5 girls)[2] met ICD-10 criteria for either expressive or mixed receptive-expressive language disorder, and of these

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[1] Portions of these data have been presented in a previous paper (Charman et al., 1997). 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. (1997), data are not presented separately on children who do not meet ICD-10 criteria for childhood autism but rather meet criteria for atypical autism, Asperger's syndrome, or pervasive developmental disorder not otherwise specified. 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.

TABLE 1. *Chronological age (CA) and Griffiths Nonverbal 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 mean SD (N = 8)	*PDD mean SD (N = 13)*	*Developmental Delay mean SD (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)

3 also had a nonverbal mental age 3 or more months below their chronological age (of approximately 20 months).

The descriptive data—chronological age (CA), nonverbal 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[3] 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 nonsignificant 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 to avoid spontaneous play being contaminated by the other tasks. Due to noncompliance, 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 .75 and 1 for over three quarters of the variables coded, and on only 1 variable did kappa fall below .50—pointing during the joint attention tasks (.47) (see Charman et al., 1997, 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 used. The experimenter (in all cases T.C. or J.S.) 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 s the experimenter displayed facial and vocal expressions of distress (i.e.,

[3] Raw scores were used because some subjects scored below the floor for assigning a language age equivalent.

cries of pain), without using words, and stopped touching the toy. After a further 10-s period of neutral affect, the experimenter showed the child that his 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 s 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 nonspecific responses to child-initiated approaches. Each child was filmed for 5 min. Each different play act produced by the child during the 5-min session was coded into the following four mutually exclusive categories according to the definitions used 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, Emde, Butterfield, & Campos, 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 meters 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 that ran from the box to the toy. They were active for a period of 1 min, 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 toward 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 s. This was repeated four 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 s. The experimenter then gave the toy to the child. This was repeated four times during the session. The key behavior recorded on each trial was whether the child looked up toward the experimenter's eyes during the 5-s 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 (Charman et al., 1997; Phillips et al., 1992), we are now persuaded by the argument that they in fact *may* be measuring a form of imperative, or requesting, gesture—because 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, 1997; see Charman, 1998, for discussion).

Imitation. The materials and method for the procedural imitation task followed those used with normally developing infants by Meltzoff (1988), and used 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 three times. At the end of the modelling period (about 2 min in all), the objects were placed, in turn, in front of the child. One nonspecific 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 s, 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 eight 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 [$\chi^2(2, N = 29) = 6.50, p < .04$]. 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 versus 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 [$\chi^2(2, N = 29) = 2.53, p =$ 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—sensori-

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*

		Sensorimotor (%)	*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

motor, ordering, functional, and pretend—is shown in Table 3. All participants across all three groups produced some examples of sensorimotor play, with 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 three in the PDD group produced any examples of pretend play, compared to half the infants in the developmental delay group—a trend that did not reach statistical significance [$\chi^2(2, N = 28] = 5.33$, $p < .10$). However, post hoc group-by-group comparison reached significance for the autism versus developmental delay group comparison (post hoc Fisher's exact test; autism × PDD = ns; autism × developmental delay $p < .04$; PDD × 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 analyzed by analysis of covariance (ANCOVA), with CA, and NVMA entered as covariates. Second, the proportion of participants who produced at least one example of each behavior across the trials completed was analyzed nonparametrically 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, $p <$

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		*Look to Box*		*Point*		*Reach*		*Vocalize*	
	Mean (%)	*SD (%)*	*Mean (%)*	*SD (%)*	*Mean (%)*	*SD (%)*	*Mean (%)*	*SD (%)*	*Mean (%)*	*SD (%)*
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)
Developmental (N = 8) delay	71	(38)*	54	(43)	6	(18)	8	(15)	17	(36)

* $p < .05$.

.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 three of the infants with autism, although this trend just missed statistical significance [$\chi^2(2, N = 29) = 5.37$, $p < .07$]. 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 four possible blocking trials, and 3.3, 3.1 and 3.5 out of a possible four teasing trials, respectively. The mean percentage (standard deviation in parentheses) 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 analyzed 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 $\chi^2(2, N = 29)$, $p > .10$].

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 four 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 analyzed 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 [$\chi^2(2, N = 29) = 6.50$, $p < .04$]. 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 versus PDD comparison (post hoc Fisher's exact test; $p =$ ns).

DISCUSSION

As indicated in the introduction, the strategy used to analyze 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 a 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 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 “nonsocial” 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, 1998; 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 infants, who imitated on over half the trials. While this contrasts with a recent study with school-age children with autism using the same tasks that 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 three 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 relatively *intact* performance of the PDD group on the empathy, joint attention, goal-detection, and imitation tasks. Their performance was 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 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. Because the most recent revisions of the two classification systems used 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" childhood 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 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 analyzing data from structured interactions with the present sample collected at age 20 months and 42 months 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 because 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) 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 programs. For example, the fact that some infants with autism *are* able to produce functional play is an important consideration when designing an intervention program 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 nonfunctional objects into the play routine (Jarrold, 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 programs 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, and imperative requests—gives a starting point for intervention programs 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.

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