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Early recognition of 1-year-old infants with autism spectrum disorder versus mental retardation

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Abstract
Previous work based on observations of home videotapes indicates that differences can be detected between infants with autism spectrum disorder and infants with typical development at 1 year of age. The present study addresses the question of whether autism can be distinguished from mental retardation by 1 year of age. Home videotapes of first birthday parties from 20 infants later diagnosed with autism spectrum disorder, 14 infants later diagnosed with mental retardation (without autism), and 20 typically developing infants were coded by blind raters with respect to the frequencies of specific social and communicative behaviors and repetitive motor actions. Results indicated that 1-year-olds with autism spectrum disorder can be distinguished from 1-year-olds with typical development and those with mental retardation. The infants with autism spectrum disorder looked at others and oriented to their names less frequently than infants with mental retardation. The infants with autism spectrum disorder and those with mental retardation used gestures and looked to objects held by others less frequently and engaged in repetitive motor actions more frequently than typically developing infants. These results indicate that autism can be distinguished from mental retardation and typical development by 1 year of age.

Autism was first described by Kanner in 1943 as a disorder characterized by an inability to relate to other people, delayed speech, language abnormalities, an obsessive desire for sameness, and an onset in early infancy. More than 50 years later, great strides have been made in terms of our understanding and treatment of autism. In particular, there is evidence that early detection of autism is important because early behavioral intervention can have a substantial impact on the long-term prognosis of many individuals with autism (Osterling & Dawson, 1994; Rogers, 1998). Studies suggest that children who receive intervention by 2–3 years of age have more positive outcomes (Fenske, Zalenski, Krantz, & McClannahan, 1985; Simmeonson, Olley, & Rosenthal, 1987). Unfortunately, autism is not typically diagnosed in children until around the age of 3–4 years (Siegel, Pliner, Eschler, & Elliot, 1988); therefore, many children do not receive intervention as early as would be optimal.

Parental reports indicate that symptoms of autism exist very early in life. Research indicates that approximately 50% of parents suspect a problem before their child is 1 year of age (Ornitz, Guthrie, & Farley, 1977), and most parents express concern to their pediatrician by the time their child is 18 months of age (Siegel et al., 1988). Thus, there are discrepancies among the ages at which symp-

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toms appear, a diagnosis is made, and intervention begins. One reason for delayed diagnosis is that current diagnostic criteria focus on impairments and symptoms that are applicable only to older children. For instance, DSM-IV criteria for autism include impairments in peer interaction, language, and pretend play, behaviors that are not present in typically developing 1-year-olds. Clinicians may therefore be understandably hesitant to make a diagnosis of autism in very young children. Before better diagnostic criteria can be developed for infants with autism, the course of their early development needs to be better described and understood.

Because early development in autism is likely to be characterized by a delay or absence of typical behaviors, it is important to distinguish the development of infants with autism from infants with mental retardation (MR). Seventy-five percent of children with autism are mentally retarded (Filipek et al., 1999). It is possible that the symptoms that parents report in infants and young children with autism are related to MR and not to autism per se. It is also possible that, although infants with autism and MR display atypical development, these clinical groups differ in the types of early impairments they show. Infants with MR would be expected to show impairments across a wide array of domains, including communication, social, and motor skills. One would expect an infant with MR and autism to show a global delay commensurate with their level of retardation. However, the infant with autism would be expected to show more severe delays in skills associated with social abilities such as attention to people and joint attention (Dawson, Meltzoff, Osterling, & Rinaldi, 1998; Mundy, 1995; Mundy, Sigman, Ungerer, & Sherman, 1986). Infants with autism who do not have MR might only be delayed in areas that are specific to autism such as social relatedness, social communication, and joint attention (Dawson et al., 1998). There is some research support for these predictions. Dahlgren and Gillberg (1989) compared parental reports of the behaviors during the first 2 years of life of infants later diagnosed with autism versus MR. Infants later diagnosed with autism were reported to display unusual social and play behaviors and perceptual sensitivities, such as overreactivity to sound. In a study of home videotapes of infants later diagnosed with autism, MR, or typical development, Baranek (1999) also found that, compared with infants with MR, infants with autism exhibited poor visual attention, required more prompts to respond to their name, excessively mouthed objects, and more frequently showed aversion to social touch. Note, however, that the sample of infants with MR in the Baranek study included infants with Down syndrome. Thus, coders were not blind to the infant's diagnosis.

Another complicating factor in the study of early development of autism is the significant variability in the age of onset of autistic symptoms. Most children with autism appear to be symptomatic early in infancy. The literature suggests that a minority of children with autism, approximately 1 in 5, display a normal course during infancy (Filipek et al., 1999). Subsequently, between 18 and 36 months of age, there is a loss of social and communication skills, as well as the emergence of autistic symptoms in the areas of attention and perseverative behavior (American Psychiatric Association, 1994). Information regarding these variations in early courses of development has come from retrospective parent reports and medical records (e.g., Brown & Prelock, 1995; Rogers & DiLalla, 1990; Short & Schopler, 1988; Volkmar & Cohen, 1989). Given the difficulties with retrospective measures, it would be very helpful to examine the behavior of "late onset" children before their parents reported the development of autistic symptoms to determine whether the children exhibited subtle symptoms at earlier ages or if they are in fact developing normally.

Unfortunately, because autism is not diagnosed in infancy, studies involving direct observation of infants with autism are lacking. Several studies have used retrospective home videotapes taken of children with autism in infancy to examine how their development differed from infants with typical development (Adrien, Faure, Perrot, Hameury, Garreau, Barthelemy, & Sauvage, 1991; Adrien, Lenoir, Martineau, Perrot, Hameury, Larmande, & Sauvage, 1993; Adrien, Perrot, Sauvage, Leddet, Larmande, Hameury, &

Barthelemy, 1992; Losche, 1990; Rosenthal, Massie, & Wulff, 1980). Early studies had a number of methodological weaknesses, including the failure to control for the age of the infants in the videotapes and environmental factors that might influence the infant's behavior on tape (e.g., overstimulating situations, number of people present, etc.). Nevertheless, these studies have consistently found that infants with autism display abnormal social, communicative, and toy play behaviors. More recently, three home videotape studies have used a more stringent methodology. Osterling and Dawson (1994) examined the home videotapes of 11 infants later diagnosed with autism spectrum disorder (ASD, autism or pervasive developmental disorder, not otherwise specified [PDD-NOS]) and 11 typically developing infants. By examining videotapes of the infant's first birthday party, the infants were observed in similar situations and were accurately matched for age. The number of adults and of children present and the location of the party were coded to ensure that the situations in which the tapes were made did not differ for the ASD and typical groups. Several social, joint attention (e.g., pointing and showing), communicative, and affective behaviors were coded, as well as unusual autistic-like symptoms. Finally, intellectual assessments were obtained on all but one child in the clinical group. Six of the 11 infants with ASD had standard IQ scores above 75, four had scores below 75 and thus were considered to be mentally retarded, and one child did not have previous test scores.

The results of the Osterling and Dawson (1994) study demonstrated that differences between infants with ASD and typical development could be identified by 1 year of age. Differences were found between the groups in three general categories of behaviors: social (looking at the face of another, seeking contact, imitation), joint attention (pointing, vague pointing, showing), and certain autistic behaviors (self-stimulation, failing to orient, covering ears). How often a child looked at the face of another person correctly classified the greatest number of infants. When combined with the behaviors of showing, pointing, and failing to orient to name, 91% of the cases (10/11 in each group) were correctly classified. Differences were found between the ASD and typical groups, even though the autistic sample was relatively high functioning in terms of intellectual ability. This reduces, but does not eliminate, the possibility that the behaviors found to distinguish the two groups were related more to MR than to autism. A control group of infants with MR is needed to fully assess this possibility.

The Osterling and Dawson (1994) study was partially replicated by Mars, Mauk, and Dowrick (1996). They utilized the same coding scheme and methodologies to examine the home videotapes of infants with PDD from ages 12 to 24 months and compared them to home videotapes of typically developing infants in the same age range. The results showed that the infants with PDD displayed less social engagement, looked at the face of another less often, and followed verbal directions less often than the typically developing infants. As mentioned above, Baranek (1999) examined the home videotapes of 11 infants with autism, 10 infants with MR, and 11 typically developing infants. Baranek added a number of sensory processing/motor behaviors to her coding scheme and found that, in combination, nine behaviors correctly classified 93.75% of the infants in the sample.

The primary goals of the present study were twofold. The first goal was to describe differences in the early development of infants who are later diagnosed with ASD versus infants who are later diagnosed with MR without autism. To our knowledge, this is the first home videotape study of infant behavior in autism to include a group of infants with MR that could not be distinguished on the basis of physical anomalies. Thus, blind coding of the infants was possible. A second goal was to replicate findings from the previous study by Osterling and Dawson (1994), which indicated that the social and joint attention behavior of infants with ASD differed from that of infants with typical development at 1 year of age.

Method

Participants

Participants consisted of three groups of children: (a) 20 children with ASD (i.e., autism

or PDD-NOS), which consisted of two subgroups: 14 with accompanying MR and 6 with normal intellectual ability; (b) 14 children with MR; and (c) 20 typically developing children. This sample was independent of the sample used in the Osterling and Dawson (1994) study. Participants were recruited from the Autism Subject Pool at the University of Washington, the Autism Society of Washington, Division of Developmental Disabilities, advertisements in local newspapers and local radio stations, University of Washington Psychology Department Infant and Child Subject Pool, and local schools. Thirty-five percent of the ASD sample received a diagnosis of autism, whereas the other 65% met criteria for PDD-NOS. All the children were between the ages of 2.5 and 10 years of age at the time of the study. Participants were excluded if they had Fragile X or Rett syndrome, Down syndrome, a sensory impairment, cerebral palsy, a history of frank brain trauma, or CNS disease. In addition, children with ASD and those with MR only were excluded from the study if they had other physical characteristics or symptoms (such as a facial dysmorphology, tic disorder, or motor tremor) that would alert coders to the child's diagnostic status. No children with ASD had to be excluded from the study based on these characteristics, and approximately 20% of children with MR who were screened had to be excluded because they had Down syndrome, sensory impairment such as blindness or deafness, moderate cerebral palsy, or other pronounced motor impairments. Participants with ASD and/or MR were administered the Stanford Binet Intelligence Scale (4th ed.; Thorndike, Hagen, & Sattler, 1986) in order to determine intellectual functioning. In addition, all participants' adaptive functioning was assessed through parent report of the Vineland Adaptive Behavior Scales. Vineland Adaptive Composite scores (Sparrow Balla & Cichetti, 1984) were derived from this measure.

All of the children with ASD received a diagnostic assessment to confirm a diagnosis of autism or PDD-NOS based on DSM-III-R criteria. DSM-III-R criteria were used because the evaluations were begun in early 1994 prior to the publication of DSM-IV. The first two authors, who are experienced in the diagnosis of ASD, assessed autistic symptoms independently via observations in structured testing and play situations in which behavioral criteria were systematically elicited. In addition to a diagnosis of autism or PDD-NOS, a score of 30 or above on the Childhood Autism Rating Scale (CARS, Schopler, Reichler, & Renner, 1986) was required. Comparisons between children with diagnoses of autism ($N = 8$) versus PDD-NOS ($N = 12$) yielded no significant differences in mean IQ or Vineland scores (all t values, $p > .10$). There was a trend for children with diagnoses of autism to have higher CARS scores than children with PDD-NOS ($t = 1.80$, $df = 18$, $p = .09$).

The comparison group of children with MR was observed by an expert clinician, and it was determined by observation and parental interview that they did not display symptoms of autism. In addition, these children had previously been administered a comprehensive diagnostic evaluation by a qualified professional (psychologist, psychiatrist, or physician) and had been determined in that evaluation to have MR without autism.

In order to assess the time of onset of autistic symptoms of each child with ASD, a structured, standardized parent interview was used to obtain a detailed developmental history. Each parent was administered a phone interview in which they were asked to report when they first noticed abnormalities in their child's development in social attention and interaction, joint attention, language and affect, and when they noticed any abnormal autistic-like behavior. If parents reported no marked abnormalities in their child's behavior at 12 months of age and their child showed a marked regression in social and communication abilities after 12 months of age, their child was categorized as having late onset ASD for the purposes of this study. For parents who reported noticeable symptoms by 12 months of age, their children were categorized as early onset ASD. Thirteen (65%) parents reported that their child had observable developmental problems by the time of their first birthday, while 7 (35%) reported that their child had normal behavior at the age of 1 year

Table 1. *Participant characteristics*

				ASD: MR vs. HF		ASD: Age of Onset	
Group	ASD	Typical	MR	MR	HF	Early	Late
N	20	20	14	14	6	13	7
Male:Female	18:2	18:2	10:4	12:2	6:0	12:2	6:0
Age (months)	64.40	66.95	67.79	56.29	83.33	60.54	71.57
	(19.51)	(27.36)	(20.27)	(11.24)	(22.44)	(16.68)	(23.59)
CARS							
M	34.83	—	—	35.61	33.00	34.27	35.86
SD	(2.39)	—	—	(2.02)	(2.32)	(2.15)	(2.64)
IQ							
M	64.00	—	53.43	48.93	99.17	66.69	59.00
SD	(26.44)	—	(9.26)	(7.86)	(19.37)	(29.90)	(19.50)
Vineland IQ							
M	55.05	102.65	51.29	53.71	58.17	55.69	53.86
SD	(7.31)	(7.26)	(10.46)	(7.49)	(6.37)	(7.47)	(7.43)

Note: All children in the study were Caucasian with the exception of one child in the typical group who was Asian and one child in the MR group who was Asian. ASD, autism spectrum disorder; HF, high functioning; MR, mental retardation.

with a regression in skills between the ages of 18 and 24 months. There were no significant differences in mean chronological age, IQ, CARS, or Vineland scores between children whose parents reported early versus late onset (t values ranged from 0.33 to −1.23, $p > .10$). Thus, the timing of the parent interview (i.e., the child's current chronological age) was not related to the parent's report of early versus late onset of autism symptoms.

In order to examine the role of mental retardation more carefully, the group with ASD was also divided into two subgroups based on full-scale IQ scores. The "high functioning" (HF) group was defined by having a full-scale IQ above 70 (M = 99.17, SD = 19.4, range = 79–136) and comprised six children (see Table 1 for a description of group characteristics). Out of the six children in this group, two were identified as having late onset ASD. The group with ASD and MR (ASD + MR) comprised 14 children and was defined by having full-scale IQ scores at or below 70 (M = 48.93, SD = 7.86, range = 45–66) and Vineland Adaptive Skill Composite standard scores below 70 (M = 53.41; SD = 7.49). Five children in this subgroup were identified as having late onset ASD.

The children in the MR group had a Composite IQ score below 70 (M = 53.43, SD = 9.26) and a Vineland Adaptive Skill Composite standard score below 70 (M = 51.29, SD = 10.49). There was no significant difference in the degree of MR between the MR group and ASD + MR group as measured by full-scale IQ, t (26) = −1.39, *ns*, and Vineland Adaptive Composite standard score, t (26) = 0.71, *ns*, or in terms of the chronological age at which testing occurred, t (26) = −1.86, *ns*.

In order to verify that the typical children were in fact developing typically, Vineland Adaptive Skill Composite standard scores were obtained, and only children with scores in the average range (i.e., 85–115) were included in the study. There were no significant differences among the four groups (ASD, ASD + MR, typical, and MR) in Hollingshead (1975) socioeconomic status F (3, 50) = 0.35, *ns*; gender, χ^2 (3, n = 54) = 3.51, *ns*; age at testing, F (3, 50) = 0.11, *ns*; and ethnicity, χ^2 (3, n = 54) = 4.6, *ns*.

Videotape coding

At the time of the assessment, the families were asked to bring in their child's home videotapes. A copy was made of the videotapes

after the assessment appointment, and the original was later mailed back to the family.

Behavioral coding. A behavioral coding system was created that included a number of gaze, social, affective, motor, communicative, and joint attention behaviors. Unless noted, all the behaviors were coded in terms of duration as the percentage of total videotaped time the child engaged in the particular behavior. Behaviors that involve a discrete action, such as pointing, were coded for frequency of occurrence. Frequency scores were then divided by the length of the child's tape, resulting in scores that reflected the rate of occurrence of each discrete behavior.

Gaze behaviors consisted of attention to people, looking at the face of another, and looking at an object not held by another. Joint attention behaviors (including behaviors considered possible precursors to joint attention) consisted of looking at an object held by another, alternating gaze between a person and an object, and pointing (measured in rate of occurrence). Communication/language behaviors consisted of vocalizing, babbling, and gesture (measured in rate of occurrence). Social behaviors consisted of seeking contact with an adult, participating in a reciprocal game such as "peek-a-boo," immediate imitation, and orienting to name being called (measured in rate of occurrence). For the code of orienting to name call, the number of times the child oriented to a name call was divided by the total number of times the child's name was called. Motor behaviors consisted of repetitive motor actions, sitting unassisted, crawling, pulling up to a stand, standing unassisted, and walking. Affective behaviors were not included in the coding system because it was found that many families turned off video recording when their child began to display the slightest negative affect. Raters were blind to child's diagnosis and coded the presence/absence of each behavior in each 1-s interval using a computerized Vertical Interval Time Code system (James Long, Inc.). One coding group was trained to code social and communication behaviors, and a separate group was trained to code motor and orienting to name behaviors. There were two coders in each group.

Situational coding. To ensure that the birthday parties and filming style of each family were comparable across groups, situational coding was carried out. To control for the setting of each party, each tape was coded for a number of situational characteristics. Each tape varied in length and the percentage of time each child was onscreen, thereby giving some participants more time to display various behaviors. However, there was no significant difference among the groups in the length of tape, F (3, 50) = 1.43, *ns*. Because of the nature of home videotapes, the child was out of view during portions of the filming. For this reason, the percentage of time each child was on-screen was calculated to control for any group differences. Additionally, some of the social behaviors could not be coded unless someone else was on the video screen with the child. The percentage of time that each child was alone on-screen was coded to control for variation across groups. Most of the motor codes include gross motor activity. The percentage of time each child was unable to move, such as being held by an adult, was coded to control for inability to move. A separate group of two coders was trained to perform the situational coding.

Interrater reliability

Interrater reliability was assessed on behavioral and situational codes by double coding 20% of the tapes and using intraclass correlation (ICC). Adequate reliability (ICC > .75) was established on all situational codes except "unable to move." Because this code controls for opportunity to engage in motor activity, none of the gross motor codes were used in the subsequent analyses. To ensure a high level of reliability for behavioral coding, only behaviors that had an ICC of more than .70 were included in analyses. The mean of all the ICCs across all the behaviors used in the analyses was .89. The behaviors and their corresponding ICC include the following: looking at people (ICC = .89), looking at objects held by others (ICC = .92), looking at objects not held by others (ICC = .98), orienting to name being called (ICC = .72), gesture (ICC = .97), participating in a reciprocal game (ICC =

.89), vocalization (ICC = .85), and repetitive motor activity (ICC = .94). Reliability was not established on some behavioral codes because of the infrequency of the behavior or because the low quality of most home videotapes made coding the behavior difficult. Coders were unable to achieve reliability on the distinction between babbling versus vocalization. These codes were combined into one code labeled "vocalization" and a high degree of reliability (ICC = .83) was established.

Group comparisons of situational characteristics

Situational characteristics of the tapes were compared across the four groups: (a) infants with HF ASD, (b) ASD + MR, (c) developmental delay without ASD (MR), and (d) typical development. There were no significant associations across the four groups in the following variables: number of adults present at the party, χ^2 (6, n = 54) = 3.85, *ns*; location of the party, χ^2 (3, n = 54) = 3.59, *ns*; percentage of time the child was alone on-screen, F (3, 50) = .06, *ns*; and percentage of time the child was onscreen, F (3, 50) = .24, *ns*. There was a significant difference among the four groups in the number of children at the party, χ^2 (6, n = 54) = 16.40, $p < .05$), with the MR only group having fewer children at the party than the other groups.

Results

Autism versus PDD-NOS

Before beginning the analyses ASD versus other comparison groups, a series of t tests examining the differences between the autism versus PDD-NOS group was conducted on each of the coded behaviors. No significant differences between children with autism versus children with PDD-NOS were found; thus, these groups were combined for all future analyses (t range = 0.16–1.19, df = 18, all $p > .10$).

Early versus late onset ASD

The behaviors of the early onset ASD group were first compared to those of the late onset ASD group. This was important because children with late onset ASD may not exhibit symptoms at their first birthday party. A multivariate analysis of variance (MANOVA) that included all behaviors as dependent measures yielded a significant group difference, F (7, 12) = 3.62, p = .025. An individual ANOVA conducted on specific behaviors indicated that the late onset group displayed significantly more instances of orienting to name, F (1, 18) = 4.58, $p < .05$, increased attention to objects held by others, F (1, 18) = 11.35, $p < .01$, and increased looking at people, F (1, 18) = 5.44, $p < .05$, compared to the early onset group. A stepwise discriminant analysis was conducted on the group with ASD using early versus late onset as the grouping factor and these three specific behaviors as the independent variables. The discriminant function correctly classified 90% of the subjects (18 out of 20) as early versus late onset. The weights in order of greatest to least magnitude corresponded to orient to name, looking at objects held by others, and looking at people (see Table 2).

These results provide support for the phenomenon of late onset ASD. Infants with late onset ASD demonstrate a different pattern of behavior than the other infants with ASD, namely increased levels of orienting to name, looking at objects held by others, and looking at others more generally. Thus, these late onset infants were excluded from further analyses when comparing groups with ASD to the MR group and the typically developing group. After removing these infants, four infants remained in the HF ASD group, and nine infants remained in the ASD + MR group.

Group comparisons: Early onset ASD, MR, and typical development

Next the differences among the early onset ASD, mental retardation, and typically developing groups were examined. Table 3 provides a summary of group means for behavior differences in the specific behaviors across the groups (with the means for high and low functioning infants with ASD presented separately). For the initial group analyses, the ASD group included high and low function-

Table 2. *Discriminant analysis related to prediction of onset of symptoms*

Predictor Variable	Standardized Discriminant Coefficient	Wilks' λ	*F* (1, 18)
Orients to name	.672	.367	9.20**
Looks at people	.703	.492	8.78*
Looks at object held by other	.741	.613	11.35*

For the function, Wilks' λ = .367, distributed as a chi-square statistic with 3 *df* and equal to 16.54 ($p < .001$), and the eigenvalue = 1.73.
*$p < .01$. **$p < .001$.

Table 3. *Behaviors shown by infants with autism spectrum disorder (ASD), mental retardation (MR), and typical development*

	ASD + MR ($n = 9$)		ASD Only ($n = 4$)		MR Only ($n = 14$)		Typical ($n = 20$)	
Behavior	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Gestures	0.07	0.17	0.02	0.04	0.10	0.17	0.29	0.29
Orients to name	0.14	0.22	0.31	0.29	0.54	0.34	0.60	0.26
Looks at object held by other	1.72	1.30	2.01	1.20	3.15	1.46	6.36	4.83
Looks at people	0.78	0.82	2.21	2.12	3.10	2.17	3.47	2.90
Repetitive action	3.72	3.85	4.84	5.57	5.05	6.03	0.70	0.91
Vocalization	0.21	0.26	2.74	3.40	0.73	1.04	1.65	2.18
Looks at object not held by other	41.73	10.10	42.20	16.34	34.97	16.36	35.07	20.30
Reciprocal game	0	0	0.19	0.37	0	0	0.37	0.89

All means are given as a percentage of the time engaged in behavior except for gesture, which is a proportion of frequency/total time of videotape, and orient to name, which is percentage of orients to the number of episodes of the child's name being called. Data from late onset children with ASD are not included.

ing infants. A MANOVA across the behaviors in Table 3 (except reciprocal game, which had variance of 0 for two of the groups) revealed significant overall differences across groups, F (21, 107) = 2.70, $p < .001$. Planned contrasts within the MANOVA were used to compare specific differences between the following pairs of groups: ASD + MR versus MR only, ASD (all) versus typical, and MR only versus typical. As shown in Table 4, infants with ASD + MR showed significantly less frequent orienting to their names and looking at others than infants with MR only. When compared to typically developing infants, infants with ASD as a whole showed significantly less gesturing, orienting to name, looking at objects held by others, and looking at people and showed significantly more frequent repetitive actions. When infants with MR only were compared to those with typical development, it was found that the infants with MR showed significantly less gesturing and looking at objects held by others and significantly more repetitive actions. These group comparisons were repeated using the number of children at the party as a covariate, and virtually identical results were obtained.

In order to determine how these behaviors predicted group membership, a discriminant analysis was conducted to see how well the behaviors predicted membership in the ASD group versus non-ASD; that is, typical and MR groups were combined (see Table 5). Only those variables in which children with

Table 4. *Group differences in behavors*

Behavior	ASD + MR vs. MR Only[a]	ASD vs. Typical	MR Only vs. Typical
Gestures	0.34 (*ns*)	2.93**	2.41*
Orients to name	3.34**	3.52**	0.55 (*ns*)
Looks at object held by other	0.99 (*ns*)	3.56***	2.74**
Looks at people	2.31*	2.23*	0.44 (*ns*)
Repetitive action	–0.77 (*ns*)	2.37*	3.10**
Vocalization	0.68 (*ns*)	0.26 (*ns*)	1.46 (*ns*)
Looks at object not held by other	0.91 (*ns*)	1.06 (*ns*)	–0.02 (*ns*)

ASD, autism spectrum disorder; MR, mental retardation.
[a]Values in each cell represent a t statistic for each planned contrast (43 df).
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 5. *Discriminant analysis related to prediction of autism spectrum disorder versus nonautism spectrum disorder*

Predictor Variable	Standardized Discriminant Coefficient of F1
Orients to name	.707
Looks at object held by other	.422
Repetitive motor action	.028
Looks at people	.404
Gestures	.100

For the function with high functioning children with autism spectrum disorder, Wilks' $\lambda = .599$, which is distributed as a chi-square statistic with 12 df and equal to 21.78 ($p < .001$).

ASD significantly differed from the typical or MR only groups were included in this model. The function correctly classified 85.1% (40 of 47) of the infants overall; 77% (10 of 13) of the infants with ASD and 88% (30 of 34) of the infants without ASD were correctly classified. The behaviors that best distinguished the ASD group from the other groups combined were orienting to name, looking at objects held by others, and looking at people.

Comparison of infants with late onset ASD and typical development

We next performed a post hoc comparison between infants with late onset ASD and infants with typical development in order to begin to characterize the early development of infants with late onset ASD, even though the late onset sample was quite small ($N = 7$). Post hoc t tests conducted for all coded behaviors revealed no differences between the groups.

Relations among IQ, symptom severity, and coded behaviors

To assess the relations among IQ, symptom severity, and coded behaviors in the ASD disorders group, Pearson correlations were conducted (Table 6). Overall, there was no general robust pattern of covariation between IQ, CARS scores, and coded behaviors. However, IQ was significantly positively related to the vocalizations made by the child ($r = .66$, $p < .01$), and higher symptom severity (i.e., higher CARS scores) was related to a higher frequency of looking at objects held by others. Given the large number of correlations, these significant findings should be viewed with caution.

Discussion

The results of the present study suggest that 1-year-olds with ASD can be distinguished from 1-year-olds with MR and those with typical development. The subgroup of infants with ASD who also were mentally retarded looked at others and oriented to their names less frequently than infants with MR only.

Table 6. *Correlations among IQ, CARS scores, and coded behaviors*

	Gesture	Orient to Name	Looks at Object Held by Other	Looks at People	Repetitive Action	Vocalization	Looks at Object Not Held by Other
IQ	0.02	0.06	–0.21	0.13	–0.33	0.66**	–0.19
CARS	–0.11	0.05	0.48*	–0.02	0.01	0.17	–0.08

*$p < .05$. **$p < .01$

One-year-olds with ASD, as a group, were less likely to look at people, look at objects held by people, orient to their name, and gesture and more likely to engage in repetitive motor actions than typically developing 1-year-olds. The infants with ASD and infants with MR used gestures and looked at objects held by others less frequently and engaged in repetitive motor actions more frequently than typically developing infants. Thus, at 1 year of age these behaviors appear to be more generally associated with developmental delay rather than being specific to ASD.

The results of the present study are consistent with a previous study by Osterling and Dawson (1994), which showed that differences in early attention to social and language stimuli distinguished infants with ASD from those with typical development at 1 year of age. Specifically, the present study corroborates the finding that 1-year-old infants with ASD looked at others and oriented to their names less frequently compared to normally developing infants. In the Osterling and Dawson (1994) study the infants with ASD also displayed fewer joint attention behaviors (pointing and showing). In the current study the pointing and showing behaviors were too infrequent in all three groups to allow for meaningful analyses. However, infants with ASD looked at objects held by others less frequently than typically developing infants. Some developmental theorists have considered this behavior a precursor to joint attention (Bakeman & Adamson, 1984).

In contrast to the Osterling and Dawson (1994) study, the present study detected differences in the amount of repetitive motor actions displayed by the two groups, and infants with ASD displayed significantly more repetitive motor actions than those with typical development. Differences in repetitive motor actions may not have been detected in the 1994 study because of a lack of power due to small sample sizes. It is important to note, however, that increased repetitive behaviors were also observed in the infants with mental retardation only, suggesting that repetitive behaviors are more generally associated with mental retardation.

It is important that, whereas infants with ASD who were also mentally retarded looked at people and oriented to their names less frequently than did infants with MR only, infants with MR did not differ from typically developing infants with respect to these behaviors. Showing interest in others by looking at people and orienting to one's name being called are behaviors that are present quite early in normal development and appear to be intact in 1-year-old infants with MR. In contrast, these early social and prelinguistic behaviors appear to be disturbed in 1-year-olds with ASD. Infants with ASD and infants with MR, however, failed to display behaviors that develop in the latter part of the first year, including joint attention and gestural communication. Thus, the results of this study suggest that impairments in looking at others and orienting to name may have higher specificity as markers of ASD at 1 year of age. These findings also support the notion that impairments in basic social attention, as reflected in looking at others and orienting to name, may developmentally precede and contribute to joint attention deficits in the early development of infants with ASD (Dawson, Meltzoff, Osterling, & Brown, 1998; Mundy, 1995).

It should be noted that the present study

did not include measures of sensory sensitivities. As previously mentioned, Baranek (1999) found that in addition to showing impairments in orienting to name, infants with ASD showed more frequent aversion to social touch and excessive mouthing. These may also be important characteristics of young infants with ASD.

At 1 year of age, children reported to have late onset ASD did not display the same impairments in social attention that were displayed by children reported to have early onset ASD. These results contribute to a body of evidence that late onset autism is a real phenomenon and that infants with late onset autism may not be easily identified at 1 year of age. Furthermore, the late onset children did not display differences in their social or communicative behavior when compared to typically developing children. Future research efforts should be aimed at obtaining larger samples of children so that children with early versus late onset autism can be more reliably compared. Ideally, if a large enough sample of late onset children were obtained, videotapes of the children could be examined at various ages between 1 and 2 years of age to better document the nature and timing of autistic regression. Research on variations in early developmental course may yield information regarding the prognosis of children with ASD. Studies examining the relation between age of symptom onset and outcome in autism have found inconsistent results. The majority of studies report that children with late onset autism are likely to have a better prognosis, such as the development of communicative speech (Harper & Williams, 1975), a higher IQ, and fewer autistic symptoms (Short & Schopler, 1988; Volkmar & Cohen, 1989). In contrast, Rogers and DiLalla (1990) found that children with early onset autism did not display more severe impairments in cognition, social abilities, and communication. Differences in clinical outcome, based on IQ, adaptive behavior, and symptom severity, were not found between the early and late onset groups in the present study. However, the sample size of the late onset group was very small.

Future clinical efforts need to be directed toward using the results from this and other studies of the early development of children with autism to construct early diagnostic screening tools that can be quickly and easily administered by professionals. One example of an early screening tool for toddlers with autism is the Checklist for Autism in Toddlers (CHAT), developed by Baron–Cohen, Allen, and Gillberg (1992). The CHAT assesses joint attention, including protodeclarative pointing (i.e., pointing to share interest in an object), gaze monitoring, and pretend play skills. Children who show impairments in these three areas at 18 months had an 84% chance of receiving a diagnosis of autism at 3 years of age (Baron–Cohen et al., 1996), indicating that the CHAT is a very useful screening tool for identifying 18-month-olds at risk for autism. With increased knowledge about early development in autism, it may be possible to extend screening efforts down to 1 year of age.

The results of this study suggest that professionals screening for ASD in 1-year-olds need to pay particular attention to the child's ability to attend and respond to their social world. In particular, professionals need to be aware of and sensitive to typical patterns and frequency of social attention and social responsiveness in order to accurately identify infants at risk for ASD. This study indicates that the children with ASD do occasionally orient to their names being called, and they also look at people around them. However, they do so much less frequently than typically developing infants and infants with MR only. Thus, it may be possible to readily observe social orienting impairments, specifically, failure to orient consistently to one's name, in a clinical evaluation. In contrast, differences in the amount of time spent looking at others were on the level of a couple of percentage points, a degree that would be very difficult to ascertain in an everyday setting. It is likely that professionals will need to examine the infant's gaze patterns in response to specific probes rather than analyzing the overall amount of social gaze in order to screen for ASD. Hopefully, the development of such diagnostic assessments will eventually allow us

to identify 1-year-olds at risk for autism and thereby lower the age at which children with this disorder begin intervention and maximize positive outcomes.

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