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Brief Report: Recognition of Autism Spectrum Disorder Before One Year of Age: A Retrospective Study Based on Home Videotapes

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INTRODUCTION

Identification of young children with autism is important in light of findings indicating that early intervention is effective for many children (Dawson & Osterling, 1997). Autism is often not diagnosed until children reach 3–4 years (Siegal, Pliner, Eschler, & Elliot, 1988). Yet 50% of parents of children with autism report that they suspected a problem before their child was 1 year of age (Ornitz, Guthrie, & Farley, 1977). One way to study the early symptoms of autism is through the use of home movies made by parents. Losche (1990) used blind raters to study infants ages 4–42 months who were later diagnosed with autism and found that, by 13 months of age, infants with autism showed differences in their use of means–end actions. Adrien *et al.* (1991) observed infant home movies of 12 children later diagnosed with autism and found that several behaviors were characteristic of later autism, including paradoxical reactions to sounds, unusual motor actions, and excitability or passivity. This work was extended in a study (Adrien *et al.*, 1993) in which blind raters coded tapes of children with autism versus typical development during the first and second years of life. Five behavior abnormalities were observed between birth and 1 year of age: poor social attention, lack of social smiling and appropriate facial expressions, hypotonia, and unstable attention. Osterling and Dawson (1994) sought to reduce some of the methodological problems of earlier home videotape studies by comparing taped segments of children's first birthday parties. This method ensured that the children were all 1 year of age and allowed for some regularity in the taping situation. Differences between 11 typically developing infants and 11 infants with autism spectrum disorder were found in three general areas: social, joint attention, and autistic-like symptoms. The specific behaviors of looking at the face of another person, showing, pointing, and failing to orient to name correctly classified 91% of the participants according to diagnostic group (10/11 with autism spectrum disorder and 10/11 with typical development). More recently, Baranek (1999) viewed 9–12 month home videotapes of children with autism, mental retardation, and typical development. Infants with autism were found to have poor visual attention, require more prompts to respond to their name, excessively mouth objects, and more frequently show aversion to social touch.

The current study aimed to characterize infants with autism spectrum disorder less than 1 year of age. To this end, the current study extended downward the study conducted by Osterling and Dawson (1994) by examing earlier videotapes taken from the same samples studied in the Osterling and Dawson study as well as the videotapes of 8 infants (4 with autistic spectrum disorder, 4 with typical development) who did not participate in the Osterling and Dawson study who were added in order to enlarge the samples. Although little is known about the symptoms of autism in early infancy, research has been able to reliably identify a cluster of behavioral impairments that characterize preschool children with autism. This cluster includes impairments in paying attention to others (eye contact, orienting), imitating the actions of others, affective responsivity, and joint attention behaviors (e.g., pointing and showing) (Dawson, Meltzoff, Osterling, & Rinaldi, 1998; Mundy, Sigman, Ungerer, & Sherman, 1986; Smith & Bryson, 1994). We predicted

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that impairments in at least two of these domains would be evident before age 1. These two domains are social attention (use of eye contact or social gaze and orienting to name being called by others) and affective responsiveness (social smiling). This prediction was based on previous findings from studies of home videotapes of infants with autism and on developmental research that has shown that typically developing very young infants regularly engage in these behaviors (Stern, 1985). In addition, infants begin to use their vocalizations in a semi-social manner at about 2 months of age, and the quantity and diversity of prelinguistic vocalizations have been linked to subsequent speech and language development (Camp, Burgess, Morgan, & Zerbe, 1987; Stoel-Gammon & Cooper 1984; Vihman, Ferguson & Elbert, 1986). Thus, it was anticipated that differences in the area of vocalizations might be evident before age 1 year.

The current study examined 8–10 month home videotape footage obtained from 15 children later known to have autism spectrum disorder and 15 children with typical development. The 8–10 month range was chosen because several relevant behaviors, such as early social imitation skills and elementary vocal communication, make their initial appearance at this time (McCall, Eichorn, & Hogarty, 1977). It was hypothesized that 8- to 10-month-old infants with autism spectrum disorder would spend significantly less time looking at others, orienting to their name being called, combining eye contact with smiling, and vocalizing in a communicative manner. We also explored whether or not young infants with autism spectrum disorder exhibit more nonfunctional repetitive behaviors than typically developing infants.

METHOD

The participants in the autism spectrum disorder group consisted of the 11 children who participated in the Osterling and Dawson (1994) study of first birthday party home videotapes and 4 additional new participants. Children in the autism spectrum disorder sample were diagnosed as having Autistic Disorder (n = 8) or Pervasive Developmental Disorder Not Otherwise Specified (PDDNOS, n = 7) according to DSM-III-R (American Psychiatric Association, 1987) criteria at a university-affiliated multidisciplinary diagnostic center. Information regarding IQ scores, scores on the Vineland Adaptive Behavior Inventory–Communication Domain, socioeconomic status (SES), and number of years of parental education was available for all but 2 participants in the autism spectrum disorder group. IQ was based on full-scale IQ from the Merrill-Palmer, Leiter, Stanford-Binet, or Wechsler Scales which was collected at preschool or early elementary school age (M = 5 years 7 mos.). Eight participants in the autism spectrum disorder group were cognitively delayed (FSIQ < 70), 1 had borderline cognitive abilities, and 4 were considered to be in the average range of intellectual functioning (IQ ≥ 85). The mean score on the Vineland Communication Subscale for the sample with autism spectrum disorder was 68 (SD = 23.4). Using a structured, standardized interview, parents were asked about child's developmental history, specifically with regard to when autistic symptoms, such as a failure to make eye contact, first appeared. For all but 3 children, parents reported that they had noticed specific symptoms of autism during the first year of life. Three children were reported by their parents to have late-onset autism; for these children, parents reported that they had observed no symptoms until the end of the second year of life.

The comparison group was comprised of the typically developing children originally recruited for Osterling and Dawson's (1994) home video study of first birthdays who had footage available of the targeted earlier age range, as well as 4 additional new participants who were recruited through the university's infant research pool. Scores on the Vineland Adaptive Behavior Inventory–Communication Domain, SES information, and years of parent education were collected on all typically developing children. Standard scores were between 88 and 123 on the Vineland Communication Subscale (M = 101, SD = 8.8). There were no differences between the autism spectrum disorder and typical groups in SES score, M = 50.0 and 53.6, respectively, $t(26) = -0.9$, ns, and years of parental education M = 15.4 and 16.5, respectively, $t(26) = -1.49$, ns. The sample was comprised of mostly middle- to upper middle-class families. The ethnicity for the autism spectrum disorder group was 93% Caucasian and 7% African American. The comparison group was 100% Caucasian.

Videotape footage varied in length from 2 to 38 minutes (M = 15.8 min., SD = 9.1). All available footage of the child between the ages of 8 and 10 months was coded in order to prevent selection bias. There was no significant difference between groups for the mean length of codable footage, $t(28) = -1.36$, ns. In order to ensure that the settings and situations depicted in the video segments did not differ for each group, tapes were coded for a variety of contextual variables, including the location of the footage, physical placement of the child (on floor, in high chair, in playpen, in arms/on lap, etc.), the number of adults on the screen, and the number of other children on the screen. Interrater reliabil-

ity for all contextual variables was assessed by double coding 20% of the tapes. Kappa coefficients ranged from .68 to .91. There were no group differences for any context variables, aside from the fact that the typically developing group spent more time in a playpen than the autism spectrum disorder group. Even taking this minor contextual difference into consideration, the fact that there were no differences in the social nature of the situations filmed, as indicated by the fact that there were no differences in the number of other people on the screen, and that there were no differences in the amount of time children in each group spent in various activities, allowed for reasonable assurance that any behavioral differences found were not due to differences in the nature of the filming situation.

A behavioral coding system was developed that documented the presence or absence of several developmentally appropriate and autistic symptom behaviors based on 1-second intervals. The behaviors coded fell into the three general categories of social behavior, communication behavior, and repetitive behaviors. Social behaviors included looking at others, looking at the face of another while smiling, and orienting to one's name being called. Communication behaviors were classified into Stage 1 and Stage 2 vocalizations, based on knowledge from the normal developmental literature on infant babbling (Stoel-Gammon, 1992). Stage 1 vocalizations consisted of simple vowel sounds ("ahh"), whereas Stage 2 involved a consonant–vowel combination "ba ba". Stage 1 vocalizations are generally related to comfort states and occur during the first few months of development. Stage 2 vocalizations have the timing of adult language patterns and are often syllables that are used to make up words. Stage 2 vocalizations generally begin around 6 months in normal development. It was hypothesized that it would be at this point that differences in the vocal behavior of infants with and without autism spectrum disorder might be detected. Repetitive behaviors coded consisted of functional and nonfunctional repetitive behaviors. See Table I for a description of the behavioral coding. Interrater reliability, based on double coding of 20% of the tapes, was assessed for the behavioral codes using kappa coefficients for the categorical codes (e.g., type of vocalization) and intraclass correlation coefficients for the frequency codes (e.g., number of times child oriented to name). Adequate reliability was achieved for all codes (kappas ranged from .65 to .71 and the intraclass correlations ranged from .66 to .90).

In order to investigate whether a professional would be able to detect behavioral differences in the home videotapes of children with autism spectrum disorder and typically developing children at 8–10 months of age, a university-based developmental pediatrician with expertise in developmental disabilities was asked to view the same footage that was coded for the analyses and to use her clinical judgment to classify each child as belonging in autism spectrum disorder or typical group. She was also asked to view footage of the same 30 children at 1 year of age in order to see if her ability to correctly classify the children improved between these two ages. As it was hypothesized that classification at the 8- to 10-month age would be more difficult than classification at 1 year, the younger footage was viewed before the 1-year footage for all participants in order to prevent the possibility that her clinical impression at the earlier time would be contaminated by behaviors she viewed during the later time. The two segments were viewed at least 4 weeks apart in order to minimize the possibility that she would remember her classification from the previous time. All 1-year-old footage was taken at the child's first birthday party, except for one participant for whom a first birthday party segment was not available. For this child, footage of Christmas was used as the 1-year-old segment. The child was 1 year, 3 weeks old at the time.

RESULTS

A multivariate ANOVA was conducted for each of the three general categories of behavior. There was no main effect of diagnostic group for the category of social behaviors (looking at others, orienting to name being called, and looking at the face of another while smiling), $F(1, 26) = 2.20$, ns, communication behaviors (Stage 1 and Stage 2 vocalizations, contingent vocalizations), $F(1, 26) = 1.46$, ns, or repetitive behavior (nonfunctional repetitive behaviors), $F(1, 28) = 1.45$, ns. These findings did not differ when the four high-functioning children (IQ $\geq$ 100) were removed from the analyses. However, when the three children whose parents reported late-onset autism were removed from the analyses, a significant main effect for diagnostic group emerged for the category of social behaviors, $F(1, 21) = 4.0$, $p < .05$, but not for the other two categories; $F(1, 22) = 1.38$, ns, for communication behaviors, and $F(1, 21) = 1.06$, ns, for inappropriate repetitive behaviors. Table II displays the means and standard deviations for the coded behaviors for the groups with early onset autism versus typical development.

Group differences in the individual behaviors that constituted the social category were examined next. With the subsample of children with late onset removed, sig-

Table I. Behavioral Coding

Social behaviors	Communicative behaviors	Repetitive behaviors
Looking at others	Simple vowel sounds (e.g., "ahh")	Appropriate repetitive behaviors (objects used in way they are intended to be used, e.g., shaking a rattle, banging a drum)
Looking at face and smiling	Consonant–vowel combination (e.g., "ba")	Inappropriate repetitive behaviors (objects used in a way they are not intended to be used, e.g., shaking a string, banging a spoon on table)
Orienting to name		

nificant group differences were found for orienting to name being called, $t(23) = -3.41$, $p < .005$, two-tailed. Whereas typically developing infants oriented 75% of the time when their names were called, infants with autism spectrum disorder only oriented to their name 37% of the time. There was also a marginally significant trend towards children with autism spectrum disorder being less likely to look at the face of another person while smiling, (*M*s = 1.5 and 4.3% for children with autism spectrum disorder versus typical development, respectively), $t(25) = -1.76$, $p = .08$, one-tailed. No main effect of group was found for the remaining social behavior variable, looking at others, $t(25) = -0.62$, ns. A stepwise discriminant analysis revealed that the percentage of times children oriented to their name being called correctly classified 78% of cases (11 out of 15 children with autism spectrum disorder and 13 out of 15 typically developing children). Adding the other social behavior variables did not significantly improve the classification rate.

The means for the coded behaviors for the small sample of late-onset children ($n = 3$) were very similar to those with typical development. For example, children with late-onset autism oriented to their names being called 83% of the time (as compared to 76% of the time for typically developing infants and 37% of the time for children with early onset autism spectrum disorder).

The data based on the clinical judgment of the developmental pediatrician were examined next. At 8–10 months, the pediatrician classified 18 out of 30 children correctly according to diagnostic group, which was not significantly better than chance, χ^2 (1, $N = 30$) = 1.2, ns. Examining the data for each group separately, the pediatrician was able to accurately predict the diagnosis of 11 out of 15 children with autism spectrum disorder, χ^2 (1, $N = 30$) = 3.3, ns; and 7 out of 15 typically developing children, $\chi^2 = (1, N = 30) = 0.07$, ns. In contrast, when the pediatrician viewed footage of the same children at 1 year of age, she did perform better than

Table II. Behaviors of 8- to 10-Month-Old Infants with Autism Spectrum Disorder Versus Typical Development

	Autism spectrum disorder		Typical development	
	M	*SD*	*M*	*SD*
Social behavior[a]				
Looks at people	32.3	11.2	34.9	10.8
Looks at face while smiling	1.5	1.6	4.3	6.7
Orient to name called	37.0	31.5	74.7	21.9
Communication behavior[b]				
Stage 1 vocalization	1.6	0.89	2.1	1.4
Stage 2 vocalization	0.013	0.029	0.004	0.017
Contingent vocalizations	0.25	0.15	0.69	0.93
Repetitive behavior[a]				
Inappropriate repetitive behavior	2.6	2.6	1.8	1.7

[a] Expressed as percentages of total amount of codable time for looking behavior and as percentages of instances of name called for orienting behavior.

[b] Expressed as frequency per minute.

chance, classifying 22 out of 30 of children correctly, χ^2 (1, N = 30) = 8.3, $p < .005$). When the groups were examined separately at 1 year, her judgment was significantly better than chance, as she classified 14 out of 15 children with autism spectrum disorder correctly, χ^2 (1, N = 30) = 11.3, $p < .001$. The one child who was misclassified was one of the children whose parents had reported late-onset autism. However, she correctly identified only 8 out of 15 typically developing infants at 1 year of age, χ^2 (1, N = 30) $p = .07$, ns. Thus, there was a tendency toward false positives, or overdiagnosis.

DISCUSSION

The results of this study suggest that differences between infants with early onset autism spectrum disorder and typical development can be detected at 8–10 months of age. The strongest finding to emerge was that 8- to 10-month-old infants with early onset autism spectrum disorder were much less likely to orient when their name was called than typically developing infants. This behavior seems to be an early emerging and enduring characteristic of children with autism spectrum disorder. In a previous study that was based on subset of the participants in the present study (11 of the 15 of the infants with autism and 11 of the 15 infants with typical development who participated in the present study also participated in the previous study), Dawson and Osterling (1994) found that failure to orient to name also distinguished the two groups at 1 year of age. This suggests that a failure to orient to name continues to be characteristic of infants with autism spectrum disorder at least through toddlerhood. In addition, Baranek (1999) found that 9- to 12-month-old infants with autism required more prompts to respond to their name. In an experimental study, Dawson, Meltzoff, Osterling, Rinaldi, and Brown (1998) found that, compared to children with Down syndrome or typical development, preschool age children with autism spectrum disorder failed to orient to their name and other social stimuli in a controlled experimental setting. Interestingly, orienting to name involves aspects of both the social and communication domains, as well as attention, so it taps nearly all the domains known to be impaired in autism. In typical development, children naturally orient to speech and faces from a very early age. The fact that children with autism spectrum disorder are not attending to this kind of information at 8–10 months may impact other aspects of social development. The present study also found that 8- to 10-month-old infants with early onset autism spectrum disorder were less likely to look at another person while smiling, although this difference was only marginally significant.

It may seem somewhat surprising that fewer differences were found between groups in the current study using footage of 8- to 10-month-old infant behavior than in the previous study by Osterling and Dawson using a similar coding scheme for footage of 1-year-old infant behavior only a few months later. One possible explanation is that the period between 9 and 12 months is a time when many new behaviors are just beginning to develop. Many complex behaviors related to social, emotional, and communicative functioning begin to emerge around 8–9 months, but these behaviors, such as advanced use of joint attention and communicative vocalizations are not solidly in place until at least age 1. There may still be significant variation in the development of these skills in the normal population at this time, making it more difficult to detect group differences. This may help to explain the pediatrician's tendency toward overdiagnosis of autism spectrum disorder in the present study.

The fact that the children with late-onset autism had to be removed from the analysis in order for group differences to be detected suggests that there is, in fact, significant variation in the early developmental course of autism. Late-onset autism is typified by a regression in social, communicative, and/or language skills in children who have had an apparently normal developmental course up to this point, occurring in the second and third years of life. Further research with a greater number of late-onset children should be conducted so that the behavior of this group can be examined more thoroughly.

The finding that the developmental pediatrician was able to classify children into diagnostic categories at a rate of 78% (22/30 children) using footage at 1 year of age, but did not perform significantly better than chance using footage taken only 2–4 months earlier suggests that during the first year of life, autism may be difficult to detect by clinicians using global clinical judgments. In fact, the developmental pediatrician who rated the videotapes in the present study tended to overdiagnose autism at the 8–10 month age. This suggests that, at very young ages, professionals will need to use specific diagnostic probes to detect autism rather than relying on clinical impression alone. It is also possible that autism simply will not be easily detectable before 12 months of age, even when probes are used.

There are several limitations to the current study. Perhaps most important, this study did not address the possibility that behaviors found to distinguish 8- to 10-month-old infants with early onset autism spectrum disorder from typically developing infants could be re-

lated to cognitive impairment rather than to autism per se. In the current sample of children with autism spectrum disorder, 62% had some degree of cognitive impairment in addition to autism spectrum disorder. It also is possible that the relative lack of significant findings for some of the social and communicative behaviors may partially reflect the milder symptomatology associated with a diagnosis of PDDNOS rather than autistic disorder (for slightly less than half of the autism spectrum disorder sample). Studies of very young infants with autism that include a control group of cognitively delayed children without autism are needed to determine the impact of cognitive impairment on the ability to detect autism before 1 year of age. In a recent study of 12-month-old infants with autism, mental retardation without autism, and typical development, Osterling and Dawson (1999) found that 1-year-olds with mental retardation versus those with autism and mental retardation did, in fact, differ in terms of specific social and communicative behaviors.

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