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Dyadic Orienting and Joint Attention in Preschool Children with Autism

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Acts of dyadic orienting (responses to attention bids by a researcher) and acts of joint attention (e.g. pointing and showing behaviors) were observed in preschool children with autism and children with developmental delay. Children with autism responded to fewer adult vocal and non-vocal attention bids that were made singly and by combining modalities (e.g. name call plus touch). Sensitivity in dyadic orienting was significantly related to child-initiated acts of joint attention (IJA). Sensitivity to dyadic orienting was also significantly related to language and non-verbal ability. These findings indicate that dyadic orienting difficulties are found alongside triadic joint attention difficulties in children with autism.

KEY WORDS: Autism; joint attention; dyadic orienting.

INTRODUCTION

One of the most reliable early indicators for a diagnosis of autism is the failure to engage in joint attention with other people. This impairment shows itself in a striking absence of behaviors such as pointing and showing objects to other people (Curcio, 1978; Loveland & Landry, 1986; Mundy, Sigman, Ungerer, & Sherman, 1986, Sigman & Ruskin, 1999). Researchers have tended to explain this impairment by focusing on the 'triadic' quality of joint attention involving awareness of another person's orientation to an object or event in the world. Yet theorists of typical development have long argued that this capacity for triadic joint attention is built upon earlier developing *dyadic* (child–other) interaction experiences between infants and parents (Bruner, 1975; Trevarthen & Hubley, 1978; Vygotsky, 1978; Werner & Kaplan 1963). Evidence from studies of typical infants supports this view (Bakeman & Adamson, 1984; Meins *et al*., 2002; Reddy, 2001; Striano & Rochat, 1999).

In contrast to research in typical development, research in autism has focused less extensively on the dyadic interpersonal foundations of triadic joint attention. This relative lack of attention to the dyadic precursors of joint attention seems surprising given that the impairment in dyadic social interaction is a defining diagnostic criterion for autism. One reason for the lack of emphasis may be that some theorists of autism place joint attention at the center of the difficulty in autism, suggesting that it provides the first distinguishable indicator of symbolic and meta-representational functioning (Baron-Cohen, 1995; Leslie, 1987). Until recently, empirical evidence has also suggested that many acts of social interaction early in life do not specifically discriminate young children with autism from children with other developmental delays (Mundy *et al*., 1986; Stone, 1997).

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Research involving the retrospective analysis of home videos taken on the child's first birthday however, has shown that certain measures of dyadic interaction such as failure to respond to name call, do discriminate children with autism (Baraneck, 1999; Osterling & Dawson, 1994) and specifically predict diagnosis of autism several years later (Baranek, 1999). More recent studies suggest that these orienting difficulties may persist across time as children become older. In two separate and unconnected laboratory studies, Dawson, Meltzoff, Osterling, Rinaldi, & Brown (1998a) and Leekam, López, & Moore, (2000) tested preschool children on their ability to orient to social stimuli such as a name call and to other non-social stimuli. Both studies found that children with autism were specifically impaired in orienting to social stimuli compared with non-social stimuli. Such findings therefore suggest that at least some measures of dyadic social interaction (e.g. response to name call) are specifically impaired in children with autism.

This evidence for social orienting difficulties in autism supports the view that children with autism have a fundamental perceptual/attentional difficulty that affects responding to social as opposed to non-social stimuli. It has been proposed that social orienting difficulty may indicate specific neurodevelopmental disturbance (Dawson *et al.*, 1998b; Mundy, Card, & Fox, 2000; Mundy & Neal, 2001) and may be associated with a network of developmental systems governing affective, motivational, cognitive and social developments from the beginning of life (Mundy & Neal, 2001). If children with autism are affected by this difficulty from early infancy, they would fail to benefit from opportunities to learn the significance or meaning of social signals and symbols creating subsequent difficulties with triadic joint attention. This account suggests that interpersonal engagement is at the center of the child's difficulty and that symbolic and meta-representational difficulties are a consequence rather than a cause of this problem (Hobson, 1993, 2002).

Empirical evidence in support of social orienting difficulties in autism has been growing in recent years, yet we still know very little about the nature of these orienting difficulties during an ongoing social interaction event. Several experimental studies have systematically tested the child's ability to orient towards the sound of a name call or hand clapping. However, these studies record only auditory bids by the researcher rather than tactile or visual bids for attention (e.g. hand wave). In the current study we examined the child's responses to a wider range of bids for attention in a more naturalistic, observational setting in which the adult's actions were not constrained. The setting also allowed us to track the child's capacity to elicit as well as respond to adult bids on a moment-to-moment basis.

In addition to studying dyadic behavior, the observation setting enabled us to systematically study the child's joint attention behavior and to investigate the concurrent relationship between social orienting and joint attention. So far, evidence has been found for an association between social orienting and one particular type of response to joint attention—gaze-following. In the study mentioned above for example, Dawson *et al.* (1998a) found that social orienting (turning towards a stimulus) was significantly related to a separate measure of gaze-following. Using a dyadic orienting measure (look to other person's eyes), Leekam *et al.* (2000) found similar results.

A problem with these studies is that the measure of orienting and the measure of gaze-following are very alike and may overlap with each other. The response involved in following another person's gaze or point, especially if the person calls 'Look' or the child's name, itself involves orienting towards a sound or movement. From results reported so far therefore, it is not clear whether social orienting is related specifically to *responding* to joint attention (e.g. gaze-following) or whether it is also related to other kinds of triadic joint attention such as spontaneous *initiating* of pointing and showing acts by the child. If so, this would indicate an association that goes beyond the similarity in following an auditory stimulus.

In the current study we therefore tested whether dyadic social orienting (looking to other's eyes in response to an attention bid) was associated not only with response joint attention (RJA) but also with initiating joint attention (pointing and showing) (IJA). As it is also possible that dyadic orienting might be associated with a range of social actions that do not involve the same kind of coordinated shared experience as joint attention, we also studied the link between orienting and a different type of social response, the child's response to an adult's request to give or take. This type of act has traditionally been described as involving regulation of behavior rather than shared attention (Mundy, Card, & Fox, 2000).

Finally, the study explored the role played by verbal and non-verbal ability in dyadic orienting and joint attention. For typically developing infants, there is evidence that joint attention ability predicts later language abilities (Morales, Mundy, & Rojas, 1998; Tomasello & Farrar, 1986). For young children with autism, triadic joint attention ability is also strongly related to both verbal and non-verbal ability (Loveland & Landry, 1986; Mundy, Sigman, & Kasari, 1994). There is mixed evidence for the association between social orienting and language ability. However, Dawson *et al.* (1998a) did not find an association between social orienting and language ability or non-verbal ability for children with autism, while Leekam *et al.* (2000) did find an association for verbal but not for non-verbal ability. Charman (2003) has also reported that gaze checking or switching may be specifically associated with language ability.

To summarize, the purpose of this study was to examine the dyadic orienting difficulties of preschool children with autism and children with developmental delay. Our first aim was to discover whether sensitivity to dyadic orienting would be affected by the type of attention bid (vocal and non-vocal) used to gain the child's attention. Second, we wanted to establish whether sensitivity to dyadic orienting would be related to the initiating of joint attention (IJA) and third we wanted to explore whether dyadic orienting, like joint attention, would be associated with language and/or non-verbal ability.

METHOD

Sample

Forty children were recruited for three separate studies being conducted at the University's developmental laboratory during a one-year period. In addition to the current study, a parent interview study (Wing, Libby, Leekam, Gould & Larcombe, 2002; Leekam, Libby, Wing, Gould, & Taylor, 2002) and an experimental study (Leekam, Lopez, & Moore, 2000) were conducted. The observation study reported here provided a separate, independent task unconnected to the other two studies.

Recruitment of children with unambiguous diagnoses was essential for the parent interview study, which was testing the validity of a new diagnostic instrument for autism. Children were selected by professionals involved in diagnostic services. None were diagnosed by the team involved in the current research. The majority in the autism group was diagnosed at Guys or Maudsley Hospital London using the Autistic Diagnostic Interview (ADI; Le Couteur *et al.*, 1989). The remainder were diagnosed by local pediatricians who use ICD-10 in their diagnostic practice. All of these children had diagnoses of autism. None had a diagnosis of Asperger syndrome.

Children in the comparison group had developmental delays (DD) but no sign of autism. They were selected by professionals (speech therapists and educational psychologists) working in schools and diagnostic centers in Kent. All the children had received diagnoses from educational or clinical services. However, they had not been formally clinically assessed for autistic disorder before the study as the policy for diagnostic services in the region meant that only children suspected of having features of autism were referred for an autism diagnosis. Professionals selecting children for the study were expressly asked to avoid selecting any child who had features of autism. Six children had known organic disorders and 12 others had global or specific developmental delays (i.e. learning and/or language impairments).

Half of the children participated in this observation task before and half after the experimental study, while parent interviews were carried out simultaneously in a separate room. Twenty children with autism (AD group) and 20 comparison children began the observation but one child with autism refused to complete the observation task and their data could not be used. The sample therefore comprised 19 children with autism and 20 children in the comparison group.

Matching and Ability Testing

An individually matched design was used, with matching based on non-verbal rather than verbal ability as the study aimed to investigate the separate effect of language-performance for each group. As joint attention abilities in children with autism are known to be sensitive to mental age and IQ level (Loveland & Landry, 1986; Mundy *et al.*, 1994), both high and low ability children were selected. Children were recruited for the study using IQ level as a selection criterion in addition to clinical group. Clinicians in diagnostic centers and schools selected children for the study according to an IQ cut-off of either above or below 70. This cut-off was chosen as it corresponded to the clinical requirements for our parallel study of diagnosis. It was also consistent with distinctions made in previous literature.

Non-Verbal Tests

Approximately half the children in each clinical group (7 AD children and 10 DD children) had IQs below 70 (range 21–58) and performance mental ages (PMA) ranging from 10 to 29 months. The remaining children (12 AD and10 DD children) had IQs above 70 ranging from 72–134 and PMAs from 2 y 11 m to 7 y 2 m. For children with IQs under 70, matching was within 0–4 IQ points and within 3 months PMA. For children with IQs over 70, matching was within 2 points for all but 3 pairs (matched within 6–10 points) and between 1 to 8 months PMA. Two autistic children (IQ 125, 129), could not be matched because of the unequal sample sizes.

It was not possible to select non-verbal tests that covered the entire ability range in the sample. The Bayley Scales of Mental Development (Bayley, 1993) was therefore used for matching for children with IQs under 70 and the Leiter International Performance Test (Leiter, 1979, LIPS-R) for children with IQs over 70. There was only one exception to this, with one child in the low-ability group (MA 29 months) being tested on the LIPS-R instead of the Bayley. The Bayley Scales measures overall mental ability, including non-verbal and verbal components whereas the LIPS-R tests purely non-verbal ability. Very high IQs and PMAs of two children in the autism group made it impossible to match them with any developmental delayed child. Therefore 2 typically developing children with IQs and MAs in the normal range provided matched comparisons. For the purpose of this study however, this group is labeled as the developmentally delayed (DD) comparison group. See Table I for details of age, mental age and IQ of each group.

The MacArthur Communicative Development Inventory (Words and Gestures CDI, Fenson *et al.*, 1993) was selected as the measure of language production and comprehension for this study as unlike other measures (e.g. the Reynell Developmental Language Scales, Reynell & Huntley, 1987), the MacArthur could be used for all children in the same sample regardless of the level of language ability and therefore provided a more complete measure of language production and comprehension. Parents completed the MacArthur questionnaire during the week of testing. As there was no standardized British version at the time of testing, specific American word variations were substituted for English equivalents. Parents of children with autism were also asked not to report echolalias. The MacArthur scale provides a restricted range of verbal mental age measures, therefore raw scores were used for the analysis.

The non-verbal matching procedure selected for this study had a specific effect on the pattern of language abilities for the two clinical groups. Because the Bayley Scales measures overall ability, including a verbal component, the result was that low-ability children with autism and developmentally delay did not differ from each other in their MacArthur CDI scores. In contrast children with autism in the high ability group, matched on the LIPS-R, had lower language scores on the MacArthur CDI than did developmentally delayed children (language comprehension, $t(17)$, 3.30, $p < .004$; language production, $t(17) = 3.97$, $p < .001$).

Procedure

All assessments took place at the University developmental laboratory in a single day session. As children also participated in a separate experimental session on the same day, the order was counterbalanced so that half the children participated in the observation study first.

The observation session consisted of a series of play tasks designed to measure initiating and response behaviors as shown in the Appendix. The observation session had two phases. Phase 1, the first 5 min of the observation session, was based on the work of Rheingold, Hay, and West (1976). During Phase 1, the child sat at a small table where various toys were placed (telephone, tea-set, doll, building blocks, books, truck, car, plastic fruit and a toy animal) and the tester sat silently on the floor slightly behind the child, in line with the child's shoulder, so

Table I. Mean Chronological Age (CA), Performance Mental Age (PMA) and IQ (PIQ) of Children in Each Clinical Group

	Group	
Mean CA, PMA & IQ	Autism ($N = 19$)	Developmental delay ($N = 20$)
CA	52.00 (11.15)	53.60 (6.83)
PMA	42.27 (23.66)	37.10 (22.22)
PIQ	79.79 (38.83)	67.45 (34.29)

Note: Mean chronological and mental age are shown in months. Standard deviations are shown in parentheses.

that in order to show or point out something to the tester the child had to turn slightly towards the adult. The parent sat completely out of the child's view, either in another room or behind the child but not visible when he or she turned to the researcher. Initiated acts of joint attention (IJA) by the child (acts of pointing and showing objects) were recorded during this phase. At the end of 5 min of Phase 1, the researcher moved position from behind the child to sit at the other side of the table, opposite the child. She then carried out a series of tasks (Phase 2) to direct the child's attention to different objects (puppets, dolls or colorful posters) that were either hanging on the walls of the room or on the floor out of child's reach. Phase 2 of the observation was based on the work of Loveland & Landry (1986) and Mundy *et al.* (1986). It used some of the items in the Early Social Communication Scales (ESCS, Mundy, Hogan, & Doehring, 1996), a structured observation of non-verbal communication. Both Phase 1 and Phase 2 were video-recorded. For Phase 1, a single video image was created which displayed the full face and upper body of both child and adult, the top of the table and the toys. For Phase 2, a split screen was used to display two images, a close-up full-face image of the child and an image showing the profile view of the child and adult and toys on the table.

Measures

Joint Attention and Response to Request

Tasks selected from the ESCS followed the design and procedure previously used by Leekam, Hunnisett, and Moore (1998). Only the higher-level tasks from each ESCS category were selected. These were, initiating joint attention (IJA), response to joint attention (RJA) and response to request (RR).

For IJA (Phase 1 and 2), the behaviors included were (i) pointing acts that were not a repeat or echo of the experimenter's earlier pointing act, (ii) acts of showing in which a toy was lifted upward towards the tester's face. Only acts that had declarative rather than requesting function were included. For the RJA behaviors (Phase 2 only), an adaptation of the original ESCS higher-level tasks (see Leekam *et al.*, 1998) was included. The experimenter produced, in total 8, RJA behaviors by turning head or pointing to different distal objects (i.e. posters and toys) positioned to the left or right out of the child's view. Two *head turn* trials were followed by 2 *non-verbal pointing* trials, 2 *verbal pointing* trials (i.e. "Look!") and 2 *naming, pointing* trials ("look at the parrot!"). Unlike the ESCS the child's name was not called during any of these trials. The RR tasks (Phase 2 only) were also an adaptation of the original ESCS tasks. The experimenter produced 7 trials in the following order: *Gestural request to give* (2 trials; begging gesture only; begging gesture plus verbal request 'Can you give me that?'). *Request to take* (2 trials; (a) gestural offer (hand object to child), (b) gestural plus verbal offer (i.e. "have the keys"). *Verbal request to give* (2 trials; (a) 'can you give me that?' E alternates gaze between child and object on table without gesture (b) 'can you give me the car?' E names object as she alternates gaze. The remaining task was new to this study (not part of ESCS). *Request to show* (1 trial only. Adult says 'Show me that" when child is playing with a toy). An eighth RR trial (request to child to look at toy held up by adult (i.e. response to showing) could not be coded because the response behavior could not be discriminated from child's ongoing behavior. The IJA, RJA and RR trials were interspersed with the occasional presentation of wind-up toys and of bubbles.

The standard ESCS normally takes between 15 to 20 min to administer. Phase 2 of our observation (see Appendix) took between 5 min 8 s and 12 min to administer. Phase 1 was approximately 5 min.

Dyadic Orienting

Measurement of dyadic orienting behavior is not part of the standard use of the ESCS. The ESCS does include other measures of social interaction but research has found that these particular measures (e.g. responses to song/tickle game) are not specifically impaired in autism (Mundy *et al.*, 1986). In place of these we applied the measure of dyadic orienting originally used by Leekam *et al.* (2000). This is operationalized as a bid for attention made by the experimenter that is immediately responded to by the child looking at the eye region of the experimenter's face. For the current study the original measure was adapted to include attention bids by the adult that were either vocal (e.g. name call) or non-vocal (e.g. touch child's hand or wave hand in front of child's face). Bids were recorded as either single bids or as combination bids (e.g. a voice and a hand bid made synchronously).

The study of dyadic orienting was incidental to the intended purpose of the observation which was originally designed to examine initiating and response forms of triadic joint attention. The researcher was therefore not given any specific instructions about how to obtain the child's attention during the observation session and was not aware that any analysis would be made of her dyadic interactions with the child.

Categorization and Coding

Categorization and coding was carried out by the second author (CR) who remained blind to the diagnostic status of the participants throughout the coding and data analysis phase.

Dyadic Orienting

Coding was done using the Observer® computer-based observation and video analysis system (Noldus Technologies, 2001). This software system facilitates the frame-by-frame analysis and temporal coding of digital video data. The system enabled the timings of observational events to be measured to the level of .04 of a second. Analysis and coding was conducted on a high-speed computer with an ultra high resolution LCD screen. Four categories of attention bid were identified following the first viewing of the tape. These were as follows.

Vocal Bids. Voice name (VN) e.g. "Jamie/Freddie, Look at me!" Voice other (VO). Vocal without name—e.g. "Hey!, Look at me!", "Come on, look at me", whistling, other paralinguistic cues. (NB if the child's name was stated amongst other vocal bids, the bid was coded as voice name (VN).
Non-Vocal Bids. Hand Touch (HT). Using hand or object in hand to touch child e.g. tickles child's stomach, takes child's hands). Hand Other (HO). Other hand movements by the researcher that do not involve touch .g. waving hand, waving finger in front of face, points to object; 'snapping fingers'; waving objects, clapping hands, bangs object on table, touching own nose, touching own face.
Single and Combination Bids. Each bid was recorded as a single bid and given a category of VN, VO, HT, HO unless two or more single bids co-occurred. When both vocal and non-vocal bids were employed synchronously, the bid was coded as a combination bid. Combinations of two vocal together or two non-vocal bids together did not occur synchronously. Therefore combination bids comprised VN + HT, VN + HO, VO + HT, VO + HO. Single and combination bids were exclusive categories.

To code bids, the coder stopped the digital video at the point at which each RJA or RR observation behavior occurred and rewound it in order to record any attention bid associated with that behavior together with the child's response to the bid. Following the coding procedures in Leekam *et al*. (2000), the child's response to an attention bid was coded as *successful* if the child's next action immediately following the adult bid was a look to the eye region of the researcher's face. For a bid to be successful the response had to be made within or at precisely 1.5 s after the onset time for the researcher's attention bid. This response latency was decided following analysis of the data from a previous research study (Leekam *et al*., 2000) which showed that 83% of children responded to attention bid within and up to 1 s and 91% of children responded within and up to 1.5 s. Response times for successful bids were measured from the video frame of attention bid onset to the first frame in which the eye gaze of the child met the researcher's gaze. Responses were scored as unsuccessful if the child failed to look to the eye region of the researcher's face within this target time of 1.5 s or if the next sequential action on the Observer record was not eye gaze but some other action by the child. If the researcher looked at the child without making a specific vocal or non-vocal bid, and the child looked back at the adult, this was not counted as an attention bid. Similarly, any direct verbal instruction associated with an observation action was not considered as an attention bids (for example, "look at the parrot"). An attention bid by the researcher was only considered valid if she was looking directly at the child at the time that she made the bid. For example, if the researcher called the child's name whilst looking in the toy box, this was not counted as an attention bid.

Scoring

Two scores were obtained (a) the total frequency of adult bids and (b) the percentage of bids in which a successful response was made (i.e. the number of successful bids divided by the number of bids made). The latter score provided the index of 'dyadic orienting'. Scores were subdivided according to bid type (vocal/non-vocal, single/combination, etc.).

Coding of Joint Attention (IJA, RJA) and Response to Requests (RR)

Coding was done by a different person (PG) who was blind to the diagnostic status of the children and to the hypothesis of the study. Coding followed the guidelines for the ESCS (Mundy *et al.*, 1996) in which the full observation period is analyzed for each child.

Coding of IJA

For both Phase 1 and Phase 2, the coding guidelines in Mundy *et al.* (1996) were used. Acts of pointing and showing were scored if they were clear and unambiguous, if they did not have a requesting function and whether or not eye contact occurred.

Coding of RJA

Coding followed the procedure outlined in Leekam *et al.* (1998) and in Mundy *et al.* (1996). A successful response was recorded for each trial if the child turned his or her head or eyes in the same direction as the researcher.

Coding of RR

Coding for request to give and take followed Mundy *et al.* (1996). A successful response was scored if the child gave the object by placing it in tester's hand (request to give), took the object from researcher's hand (i.e. a gestural request to take). For verbal request to give, a successful response was scored if the child picked up the object immediately from the table on which it has been placed by researcher. For our new measure of request to show, a successful response was scored if the child lifted up/demonstrated toy. For each request type a successful response was recorded if this was immediate and uninterrupted.

Scoring

For both RJA and RR trials, there was individual variability in the total number of trials given. Therefore the score was the percentage of correct responses (i.e. calculated as the number of acts correctly responded to divided by the number of acts completed). For IJA, the score was made up of the total frequency of acts of pointing and showing initiated during Phase 1 and Phase 2.

Inter-Rater Reliability

For each behavior (dyadic orienting, response to joint attention, response to requesting, initiating joint attention), at least 25% of the cases, half from each clinical group, were randomly selected and coded by a second rater. The second rater for the measures of dyadic orienting was a person who had not participated in any of the other coding for the study and who was blind to the hypothesis of the study. The second rater for the measures of IJA, RJA and RR was the second author (CR) who coded these cases in a second pass through the data while still blind to clinical group and to the hypothesis of the study. Reliability using kappa correlation coefficient was as follows; Dyadic Orienting, $k = .90$, RJA $k = .64$, RR, $k = .83$, IJA, $k = .83$.

RESULTS

Dyadic Orienting

Data were not normally distributed. Non-parametric statistics were therefore used and because of the large number of tests involved, an alpha level of .01 was set.

Observation time was equalized for each child in light of previous research (Leekam *et al.*, 2000) showing that the length of time in which the child is engaged with the adult is likely to influence the frequency of adult attention bids. The minimum observation period for every child (the first 5 min 8 s) is therefore reported. Results are reported in two parts. First the number of attention bids made by the adult are reported, then the percentage of attention bids responded to by the child (dyadic orienting).

Number of Attention Bids Made by the Adult

One child in the Developmental Delay (DD) group did not need any attention bids from the adult. He oriented to the adult immediately she looked at him without needing to have his name called or any other type of attention bid. This case (IQ 115 PMA 80) was therefore removed from subsequent analysis. The corresponding matched case (IQ 125, PMA 77) was retained in the analysis to avoid reducing the sample size further after checking that each result remained the same regardless of this child's inclusion.

The 19 DD children and 19 AD children in the final sample received between 1 and 34 attention bids from the adult. Table II, row 1 shows the mean number of adult bids for each group. Children with autism elicited more attention bids from the adult than comparison children ($U = 95.0$, $p < .01$). Further analysis of the different type of bids showed no significant group difference in the number of vocal bids or non-vocal bids. In addition, when analyzed separately, no group difference was found for the number of single bids or for combination bids (vocal and non-vocal bids made synchronously) although the difference for combination bids approached significance at the .01-level (AD mean 7.68, sd 8.82; DD mean 2.16, sd 2.98; U = 99.5, $p < .017$).

Within group analysis showed that both groups received more vocal (VN /VO) than non-vocal bids (HT/HO) from the adult. (AD group; Wilcoxon Z = –03.3, $p < .001$; DD group, Wilcoxon Z = –03.3, $p < .001$). The DD group also received more single than combination bids (Z = –03.5, $p < .001$) whereas for the autism group, the proportion of single and combination bids did not differ.

Percentage of Bids Responded to by Child (Dyadic Orienting)

Table II, row 2, shows the mean percentage of total adult bids that were responded to by children. Children with AD were worse at responding to adult attention bids than children with DD (U = 63.5, $p < .001$) (see Table II). Children with autism also responded to fewer vocal bids (U = 69.0, $p < .001$) than comparison children. There were insufficient non-vocal single bids (8 non-vocal bids to AD children, 4 to DD children) to test group differences in responses to hand-touch and hand-other categories. Taking single bids as a whole, AD children successfully responded to significantly fewer bids than DD children (mean percentage of 28.2 bids (sd 28.0) compared with 65.8% (sd 32.3) by DD children (U = 67.5, $p < .001$).

AD children were also poorer at responding to combination bids although the group difference did not reach significance at the .01-level (U = 40.50, $p < .036$). As only 10 comparison children and 16 children with autism received combination bids, analysis was restricted by the effect of the small sample size. Analysis of each type of combination bid showed that the researcher made significantly more unsuccessful bids to children with autism in every combined category with one result reaching .01-level (VN + HO, U = 103.0, $p < .003$).

To test further the group difference in responsiveness using a categorical method, children were categorized according to whether they responded to more than or less than 50% of adult attention bids. Results showed that only 3 children with autism responded to at least 50% of bids compared with 12 children with developmental delay ($\chi^2 = 8.92$, df 1, $p < .003$).

Separate group comparisons were conducted for high ability children (IQ over 70) and low ability children (IQ below 70). With respect to the number of attention bids elicited, no significant differences at the .01-level were found for either high or low ability groups. With respect to proportion of bids responded to, the difference between clinical groups did not reach significance at the .01-level for high ability children but did for the low ability children. Low ability AD children responded to 17% (sd 6) of bids while low ability DD children responded to 62% (sd 33) of bids (U = 5.0, $p < .003$).

Joint Attention (RJA and IJA) and Response to Request (RR)

Non-normal distribution of the data meant that non-parametric (Mann Whitney) analyses were used. Data for all children (19 AD, 20 DD) were included in the analysis and a significance level of .01 was applied.

Children with autism produced fewer initiating acts of joint attention than children with developmental delay (IJA) (mean AD = 2.21 (sd 4.04), mean DD = 4.95 (sd = 5.41) (U = 99.0, $p < .01$). They also responded to fewer adult requests (RR) (mean percent AD 66.2 (sd 22.1), mean percent DD 91.2 (sd 12.2)) but this difference did not reach .01-level. No group difference was found for performance on RJA tasks. Performance on RJA trials was higher than expected for both groups (mean percent AD = 83.9 (sd, 24.3) DD = 91.2 (12.2). Further analysis revealed that all children performed particularly well in response to the trials in which pointing and

Table II. Mean Number of Dyadic Attention Bids and Percentage of Bids Responded to

	Group[#]	
Attention bids	Autism	Developmental delay
Mean No. bids by adult	15.21 (9.99)	7.84 (5.52)
Percentage of bids responded to by child	30.4 (27.1)	66.0 (30.0)

Standard deviations are shown in parentheses.
[#]N = 19 in each group. One child excluded from developmental delayed group.

other cues occurred, accounting for the high level of performance.

Separate group comparisons for high ability (10 DD, 12 AD) and low ability (7 AD, 10 DD) children, revealed one significant group difference at the .01-level. Low ability children with autism had fewer IJA behaviors than DD children (U = 3.5, $p < .001$).

Association between Dyadic Orienting, Joint Attention and Response to Requesting

Spearman's correlations with alpha level at .01 tested whether dyadic orienting (proportion of successful bids) was associated with either joint attention (IJA, RJA) or response to requesting (RR). For this analysis we used not only the original measure of RJA but in view of the ceiling performance for the pointing trials, a separate score was generated for the two head turn trials. This produced a separate binary measure of correct performance for the two head turn trials. (Inter-rater reliability for this measure was higher than for the original measure ($k = .74$). Analyses for all children together showed that dyadic orienting was significantly associated with each of the observation behaviors. IJA ($r_s = .54$, $p < .001$), RR ($r_s = .44$, $p < .006$) RJA original measure ($r_s = .41$, $p < .010$), RJA head turn measure ($r_s = .40$, $p < .013$).

Separate correlations between dyadic orienting and IJA, RJA and RR were then run for each clinical group. For the AD group, IJA correlated significantly with dyadic orienting, at the .01-level (IJA, $r_s = .62$, $p < .005$). Associations between dyadic orienting and RJA were significant at the .05-level but not at the .01-level (original measure $r_s = .46$, RJA head turn measure, $r_{pb} = .47$). No significant correlation was found for RR, $r_s = .36$, ns). The DD group showed no significant correlations. When correlations were run for high and low ability children in each clinical group, no associations were found that reached the .01-level (Table III).

Association with Verbal and Non-Verbal Ability Measures

Spearman's correlations were run to test the associations between each of the four ability measures (PMA, IQ, language comprehension and language production) and each of the observation behaviors; dyadic orienting, IJA and RJA and RR. For this analysis the more conservative RJA head-turn measure was used. Due to missing data (MCD1 questionnaires not returned by parents), analyses were based on 38 children receiving attention bids for analyses involving PMA and IQ and 35 for analyses involving language scores. Table IV gives a summary of the associations. As can be seen, associations at the .01-level were found for the autism group only.

Analyses for high and low ability children in each group revealed significant associations between dyadic orienting and ability measures only for the high ability autism group at the .01-level for language comprehension and PMA (comprehension, $r_s = .91$, $p < .001$; pma, $r_s = .77$, $p < .004$; IQ, $r_s = .67$, $p < .018$). One significant association at the .01-level was also found between IJA and PMA for the low ability DD group only (pma, $r_s = .79$, $p < .006$).

DISCUSSION

One of the earliest and most robust symptoms of autism is the failure to engage in triadic joint attention by the second year of life. Some theorists argue that this impairment is the earliest indicator of a 'metarepresentational' impairment (Baron-Cohen, 1995; Leslie, 1987). Others propose that the impairment in joint attention emerges from more basic

Table III. Spearman's Correlations between Measure of Dyadic Orienting and Measure of Joint Attention for Each Group

	Dyadic orienting	
Joint attention	Autism	Developmental delay
Initiating joint attention	.62*	.25
Response joint attention[a]	.47	.37
Response to request	.36	.26

*$p < .01$.
[a]Head turn measure.

Table IV. Spearman's Correlations between Language and IQ Scores and Observation Behaviors for each Group

Autism					Developmental delay			
Observation behaviors	Language comprehension	Language production	PMA	IQ	Language comprehension	Language production	PMA	IQ
Dyadic orienting	.78**	.59*.	.62*	.54	.42	.26	.31	.34
Initiating joint attention	.61*	.71**	.72**	.77**	.07	−.04	−.03	−.02
Response joint attention	.66**	.50	.56	.59*	.16	.31	.40	.42
Response to request	.35	.13	.31	.18	.46	.25	.19	.18

*$p < .01$, **$p < .001$.
IQ was calculated using Bayley Scales of Mental Development (Bayley, 1993) for children with IQs under 70 and Leiter International Performance Test (Leiter, 1979) for children with IQs over 70. Language score from MacArthur CDI (Fenson *et al.*, 1993).

dyadic (child−other) interaction difficulty stemming from social orienting (Dawson, 1998a; Mundy & Neal, 2001) or from interpersonal engagement difficulties (Hobson, 1993; 2002). The purpose of this research was to investigate the nature of dyadic interaction difficulty in more detail and to examine its association with a range of the triadic joint attention behaviors and with verbal and non-verbal ability.

The study had three main aims. First, we wanted to investigate whether dyadic orienting (response to an adult attention bid) would be affected by the type of attention bids that an adult makes. Results showed that compared to the comparison group, children with autism oriented to fewer dyadic (vocal and non-vocal) bids in general and to fewer vocal and fewer single bids in particular. Second, we wanted to investigate the association between dyadic orienting and triadic acts of joint attention, particularly child-initiated acts of joint attention (e.g. pointing and showing objects to others). We found a significant association between dyadic orienting and initiating joint attention (IJA) that was significant for the autism group independently. Finally, we aimed to explore the relationship between dyadic orienting and verbal and non-verbal ability. Here we also found a significant association between dyadic orienting and both verbal and non-verbal ability that was significant for the autism group independently.

These results extend previous research findings on social orienting in autism and its link with joint attention and language. Previous research has shown that children with autism are less responsive to auditory bids such as name calls. Our study showed a similar finding when using a range of bids for attention including name call, other vocal (e.g. 'look'), visual (e.g. hand wave) and touch. Taken together, these bids elicited eye-contact less frequently from children with autism than from children with developmental delay. Although significant effects were found for only vocal bids and single bids independently, the small sample size was a major limitation and further research using larger samples and including parents as well as an unfamiliar adult is needed. This finding may be especially relevant to further research and intervention with low-ability children as we found that low ability children in particular were less responsive to attention bids than low ability comparison children.

These results also extend previous findings of an association between dyadic social orienting and triadic joint attention Previous research has shown a link between dyadic orienting and response joint attention (RJA) (Dawson *et al.* (1998a, b; Leekam *et al.*, 2000) but it was not clear if this association would extend to other initiated forms of triadic interaction (IJA). Our research shows that it does. Significant associations were found between dyadic orienting (DO) and initiated joint attention (IJA) and these associations were significant separately for children with autism.

This finding supports recent social orienting models of autism (Dawson *et al.*, 2002; Mundy & Neal, 2001). Both Dawson *et al.*'s and Mundy & Neal's models propose that there are impairments in a network of neural systems that may be apparent from the early months of life. As Dawson's research emphasizes the response-based measures of orienting and RJA, while Mundy's research focuses on dual processes involved in both IJA and RJA, the current findings may potentially add further information to our understanding of the link between responding and initiating behaviors. The significant association between dyadic orienting and IJA suggests that the capacity for low-level dyadic orienting to the sounds or touch of another person is connected not simply to functionally similar behaviors within a triadic gaze-following task but also to the capacity to initiate and coordinate shared experiences with others.

Finally, these findings extend previous research of an association between triadic joint attention and language. Associations between triadic joint attention and language development have been established in the literature. Our results supported these findings, showing significant autism-specific associations between triadic joint attention and both language and non-verbal ability. However, our study also showed new evidence for an association between dyadic orienting and both verbal and non-verbal ability. Previous research has shown mixed evidence for this association. Some studies (e.g. Dawson, 1998) have not shown such an association, while others have shown an association between language ability and dyadic orienting (Leekam *et al*., 2000) or gaze-checking (Charman, 2003).

The potential relevance of dyadic orienting to language acquisition in children with autism is emphasized by Siller and Sigman (2002). In their study they found that the strategies caregivers use to interact with their autistic children had significant effects on their children's language ability up to 16 years later. The strategies most successful were those in which the caregiver focused on the child's topic of interest rather than making a demand to shift attention. Siller and Sigman (2002) suggest that the ability of children with autism to shift attention might be impaired, leading to the need for these kinds of strategies by parents. However, other evidence suggests that the shifting of attention between events may not be a problem for children (Leekam *et al*., 2000; Pascualvaca, Fantie, Papeorgiou, & Mirsky, 1998). Instead, the initial difficulty might lie in the necessary engaging of the child in dyadic interaction because without this engagement it may be difficult to redirect the child's attention at the adult's request. Our results showed that the number of bids made by the researcher did not make a difference to the effectiveness of gaining eye contact with the child. Unless the caregiver does focus on what the child is attending to, the effort and time to engage and direct the child's attention might be both time consuming and counter effective and fail to facilitate language growth.

Although children with autism may not have a general problem with attention shifting, they may have a problem that particularly affects orienting to social stimuli at both a reflexive (exogenous) level and at the level of voluntary (endogenous) control (Leekam & Moore, 2001). As Posner (1980, p. 19) points out, no external cue is entirely reflexive and it will only summon attention if it is important to the subject. Therefore the difficulty in dyadic orienting may be seen as a difficulty with endogenous attention that relies on some level of meaning or expectation. For individuals with autism, human stimuli may simply not be important early in development and this lack of salience may lead to a failure to learn the reward value of dyadic interactions (Dawson *et al*., 1998b; 2002; Mundy, 1995). Children with autism may therefore fail to pick up on some of the expressive vocal or tactile information provided in social attention bids and may rely on other information such as gross visual movement when responding to human cues such as head turns and pointing. This account is consistent with findings for both very young typical infants (Farroni, Johnson, Brockbank, & Simion, 2000; Moore, Angelopoulos, & Bennett, 1997) and for children with autism (Leekam *et al*., 1998). This kind of explanation fits with the view that children with autism have reduced ability to extract salience from social stimuli (Klin, Jones, Schulz, & Volkmar, 2003).

To conclude, these findings appear to support the proposal that children with autism have difficulties in social orienting (Dawson *et al*., 1998a, b; Leekam *et al*., 2000; Mundy & Neal, 2001; Swettenham *et al*., 1998) and indicate that this impairment is related not only to gaze following but also to the ability to initiate acts of joint attention and language ability. These results therefore provide support for focusing on both dyadic orienting and triadic joint attention in the development of early diagnostic and early intervention measures.

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Appendix. Schedule of Joint Attention and Requesting Tasks

Phase	Task type	Adult actions in order	Observation behavior
1	Spontaneous play	None	IJA
2	Adapted ESCS tasks*		
	Request to give	Hand toward child palm upward (beg)	RR
	Request to give	Hand (beg) towards object—can you give me that?	RR
	Head turn	Turn head to right	RJA
		Wind-up toy (clown)	
	Head turn	Turn head to left (blue and yellow duck)	RJA
	Point	Point and look to right . (black and white dog)	RJA
	Request to take	Give toy alternating gaze (string doll)	RR
	Request to take	Give toy alternating gaze , say (have these keys)	RR
	Point	Point and look to left (tiger)	RJA
	Request to look	Show, hold up toy and say—look at this	RR
		Activate toy	
	Point +look!	Point and look to right—say 'look' (brown dog)	RJA
	Request to give	Say—Can you give me that—alternate gaze	RR
	Request to give	Say—Can you give the keys—alternate gaze	RR
	Point +look!	Point and say look! (left) playbox	RJA
	Request to show	Adult says—Show me that	RR
	Point + name object	Point to right—say 'look at the parrot'	RJA
		Blow bubbles	
	Point + name object	Point to right—say 'look at the poster'	RJA

Abbreviations: IJA, Initiating Joint Attention; RJA, Response Joint Attention; RR, Response to Request.
Note: IJA behaviors were also recorded in Phase 2.

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