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The emergence of nonverbal joint attention and requesting skills in young children with autism

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ABSTRACT

Joint attention (JA) skills are deficient in children with autism; however, children with autism seem to vary in the degree to which they display joint attention. Joint attention skills refer to verbal and nonverbal skills used to share experiences with others. They include gestures such as pointing, coordinated looks between objects and people, and showing. Some nonverbal gestures are used to request rather than merely to share. These requesting gestures include reaching, pointing to request, and giving to gain assistance. Although these skills also relate to expressive language development, we know little about when they emerge and how they change as language develops in children with autism. Several studies report the emergence of nonverbal requests in children with autism to be similar to that of typically developing children, but other studies report impairments in such skills. This study investigates the emergence of nonverbal JA and requesting skills in typically developing children and in children with autism with expressive language ages between 12 and 60 months, using both a both cross-sectional and a longitudinal design. Results suggest that the sequence of JA skill emergence in autism differs from a normative model, while the sequence of requesting skills emerges in accord with typical development. Furthermore, several joint attention skills appeared to emerge later than in typical children. With regards to intervention it appears that a curriculum based on a normative developmental model for the emergence of requesting skills is mostly appropriate for use with children with autism. However, since children with autism acquired nonverbal joint attention skills in a sequence that differed from a normative model, it might be that a non-normative autism-specific joint attention curriculum would be more likely to benefit children with autism.

Learning outcomes: The reader will (1) identify 3 specific initiating gestures used to communicate for the purpose of joint attention, (2) identify 2 specific nonverbal responsive joint attention skills, (3) be able to state that children with autism appear to develop specific nonverbal requesting gestures in a similar sequence to typically developing children, (4) be able to state that children with autism appear to develop specific nonverbal joint attention gestures in a different sequence than that of typically developing children, and (5) be able to identify 2 specific nonverbal joint attention skills that appear significantly impaired in children with autism relative to typically developing children.

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1. Introduction

Deficits in social communication skills characterize young children with autism. Indeed, a body of research on the nonverbal social communication of children with autism has focused on two communicative functions, namely communicating to request and communicating for the purpose of joint attention. Requesting gestures are meant to elicit aid from another person, attain an object, or receive assistance in manipulating objects. Communication for joint attention purposes involves the use of gestures to share interest with another person about an object or an event. These are broad working definitions accepted by autism researchers (Bakeman & Adamson, 1984; Mundy, Sigman, & Kasari, 1993).

Studies examining nonverbal requesting and joint attention gestures in young children with autism have generally reported on coding of direct observational measures that yield frequencies of specific requesting and joint attention gestures. The studies usually report on either similarities between appropriately matched children with autism and typical children (meaning that children with autism used a specific gesture at a similar rate to typically developing children) or differences in their use of gestures (meaning that children with autism used a specific gesture at a statistically significantly reduced rate than did typically developing children). Many studies have found that children with autism rarely use some gestures and use others at significantly reduced rates when compared to typically developing children; these gestures are considered impaired.

Several articles suggest that children with autism may be no different from typically developing peers in their ability to use gestures to make requests (Attwood, Frith, & Hermelin, 1988; Baron-Cohen, 1989, 1993; Charman et al., 1997; Loveland & Landry, 1986; Mundy et al., 1993; Mundy, Sigman, Ungerer, & Sherman, 1986). Other studies, however, report impairments in requesting skills (McEvoy, Rogers, & Pennington, 1993; Phillips, Gomez, Baron-Cohen, Laa, & Riviere, 1995; Sigman, Mundy, Ungerer, & Sherman, 1986) suggesting that research to date remains inconclusive on whether children with autism are impaired in their use of gestures for requesting purposes.

There seems to be consensus that joint attention is severely impaired in children with autism (Kasari et al., 2005). This raises considerable concern in that significant associations have been found to exist between joint attention skills and the emergence of later language abilities (Charman et al., 2003; Loveland & Landry, 1986; Mundy, Sigman, & Kasari, 1990; Tomasello & Farrar, 1986). Another avenue of research has also considered joint attention abilities as possible precursors of cognitive perspective taking or theory of mind (Baron-Cohen, 1993; Roeyers, Van Oost, & Bothuyne, 1998). It is apparent that the ability to engage in joint attention with others plays an important role in the development of both language and social cognition.

The exact nature of autism-related impairments in these two communicative functions remains unclear. There is some evidence that impairments exist in the reaching, giving, and pointing (both proximal and distal) gestures used for requesting (McEvoy et al., 1993; Phillips et al., 1995; Sigman et al., 1986). Current research also suggests impairments in the following nonverbal joint attention skills (definitions are in Appendix A): coordinated joint looks (the child either looks from an object to another person, then back to the object, *or* from another person to the object, then back to the person; eye contact alone without reference to an object or event is not considered joint attention), following another person's gaze (distal), following another person's point (proximal and distal), pointing (proximal and distal), and showing (Charman et al., 1997; Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998; Mundy et al., 1990; Mundy, Sigman, & Kasari, 1994; Swettenham et al., 1998). Nonetheless, it remains unclear which specific gestures are impaired or if specific gestures are impaired regardless of a child's developmental level. It is likewise unclear whether both the responsive (following gaze or following point) and the initiating (coordinated joint looks, pointing and showing) forms of nonverbal joint attention as well as the initiating forms of nonverbal requesting (reaching, giving, and pointing) are affected and how the development of such gestures differs from that of typical children.

1.1. Nonverbal joint attention and requesting in typical children

Research on typically developing children has charted the developmental emergence of most forms of nonverbal joint attention and requesting. The earliest nonverbal joint attention skill is coordinated joint looks, which seems to emerge at around 6 months chronological age (CA) and becomes more intentional around 12 months CA. Between approximately 10 and 14 months CA, children begin to use nonverbal joint attention gestures to refer to an object that is a shared focus of attention for both the child and the adult (Butterworth & Cochran, 1980). Showing appears at around 10 months CA (Bates, Camaioni, & Volterra, 1975). Children follow another person's gaze by 12 months CA (Butterworth, 1991; Butterworth & Cochran, 1980; Leung & Rheingold, 1981; Murphy & Meisser, 1977). Typically developing children reach and give items to request by approximately 13 months CA (Bates et al., 1975), reliably follow points by 14 months CA (Murphy & Meisser, 1977), and point with clear communicative intent at around 16 months CA (Bates et al., 1975; Bates, O'Connell, & Shore, 1987; Morisette, Ricard, & Decarie, 1995). Thus, by 20 months CA typical children use a variety of gestures for joint attention and requesting purposes. These include responsive skills where the child responds to another person's focus of attention (following gaze, following points), and initiating skills (coordinated joint looks, pointing, showing) where the child uses a communicative gesture to initiate a shared focus of attention. Some gestures only communicate a request (e.g., reaching); some only communicate joint attention (e.g., following another person's point or gaze, coordinated joint looks or showing). Others communicate either function (e.g., pointing). As these gestures emerge, typical children use them both for requesting and joint attention (Bates et al.,

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1975; Bruner, 1983). Indeed social communication gestures such as pointing are not replaced when language appears, but rather continue to accompany and add emphasis to language (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Dobrich & Scarborough, 1984; Goldfield, 1990).

1.2. Nonverbal joint attention in children with autism

There is substantial evidence that children with autism tend to have deficits in both responsive and initiating joint attention skills. In this paper, we review studies on joint attention gestures in children with autism at specific developmental ages to better understand when impairments in specific gestures emerge. Several studies examined children between 17 and 30 months mental age (MA). All of the studies reported impairments in both responsive (following point and gaze) and initiating skills (coordinated joint looks, pointing, showing). Charman et al. (1997) and Swettenham et al. (1998), for example, found that children with autism around 17 months MA engaged in significantly fewer coordinated shared looks than did their typical counterparts. Mundy et al. (1990, 1994) found that both responsive (following gaze and point) and initiating joint attention (coordinated joint looks, showing and pointing) were considered significantly impaired in children at 17 months MA. However, Mundy et al. (1994) also reported on a group of children with an average MA of 30 months. At that mental age they found that children with autism were similar to typically developing children on responsive joint attention (following gaze and pointing). Of the initiating skills, coordinated joint looks (the earliest developing skill in this area of typical development) were also similar; but pointing and showing were impaired. Dawson et al. (1998) reported conflicting results. Their sample of children with autism with the same MA (30 months) was significantly impaired in their ability to follow another's gaze or follow a point.

Although the research is limited, some studies do suggest that initiating gestures are significantly impaired in young children with autism. It remains unclear whether responsive gestures continue to be impaired as children develop, since few studies narrow their sample to children at specific mental ages. The two existing studies that have targeted specific developmental ages report conflicting results. Studies to date are also limited to children with autism between 17 and 30 months MA. Thus, it is unclear whether impairments continue to exist as children with autism develop further and acquire language.

1.3. Nonverbal requesting in children with autism

Research on the development of nonverbal requesting gestures (reaching, giving and pointing) in children with autism is also inconclusive. Mundy et al. (1994) found that children with a mean MA of 17 months were similar to typically developing children on the gesture of reaching that tends to develop earliest in the normative sequence. However, for other requesting gestures (giving a toy or pointing to toys out of reach), the children with autism were significantly impaired. An earlier paper by Mundy et al. (1990) indicated that children with autism at 20 months MA did not significantly differ in frequency of requesting behaviors; however, the study employed a composite variable of multiple requesting forms (including reaching, giving and pointing) rather than specific gestures. As a result, we do not know whether certain nonverbal requesting forms (e.g., "reaching" as was found in Mundy et al.'s 1994 paper) were more prevalent than other forms (i.e., giving and pointing) or whether these forms change with development.

Conflicting data also exists in the two studies with more developmentally advanced children. Mundy et al. (1994) reported that children with an average MA of 30 months were similar to typical children on the gestures giving and pointing. However, Phillips et al. (1995) found that few children with a MA of 40 months displayed reaching or pointing to request. These inconsistencies in the data further suggest a need to investigate the use of these gestures across varying developmental levels.

2. Summary

Only a handful of studies exist that chart the presence of specific nonverbal joint attention and requesting gestures in children with autism at different points in development. As a result, it remains unclear if children with autism tend to be impaired in all nonverbal requesting and joint attention skills compared to typically developing children, regardless of developmental functioning, or if certain gestures are more impaired than others. It could be that that the timing of when gestures emerge is different, and it is possible that children with autism do not develop gestures in the same sequence as typical children.

In this study, we address the following related questions. First, do certain gestures in children with autism emerge delayed relative to typical development? (In other words, could it be that certain gestures emerge in the same developmental trajectory as in typical development but later than what one would expect?) Second, do children with autism acquire specific nonverbal joint attention and requesting skills in a non-normative sequence (in a different developmental trajectory than what would be expected)? To answer these questions we report on two studies. In the first study, we constructed a normative model of the emergence of nonverbal joint attention and requesting based on the literature in typical development and on data from a small sample of typically developing children. We then charted the developmental trajectory of nonverbal joint attention and requesting in children with autism at different stages of language development using cross-sectional data and presented a possible non-normative sequence of skill emergence. The second study tested this non-normative model of nonverbal skill emergence using longitudinal data in a different sample of children.

3. Study 1

3.1. Method

3.1.1. Participants

In Study 1, two samples of young children were recruited: children with autism, 36–72 months CA, and typical children 20–52 months CA. The typical children were recruited from local preschools and day care centers by sending flyers home. Children with autism were recruited from the records of the Autism Evaluation Clinic at UCLA's Neuropsychiatric Institute. Letters describing the study were sent directly to parents who had indicated an interest in participating in research. For both groups, it was at the discretion of the parent to contact the investigators.

We matched typically developing children to children with autism in groups based on expressive language age (ELA). The matching procedure is described below. In all, we assessed 39 children with autism and 21 typical children. We excluded 4 children with autism due to incomplete data and 3 typical children due to concerns that they were not typically developing. The final sample for the study included 35 children with autism and 18 typically developing children.

The sample of children with autism ($n = 35$) was comprised of 5 females and 30 males and was predominantly Caucasian (33 were Caucasian, 1 was Asian American, and 1 was African American). The children with autism had an average CA of 53.6 months (see Table 1). The sample of typically developing children ($n = 18$) had 9 females and 9 males and was predominantly Caucasian ($n = 12$), with 6 participants who were Asian American. They had an average CA of 28.8 months (see Table 1). Although it is relatively small, we included the sample of typically developing children to confirm, relative to the current literature, the timing of when specific skills emerge.

3.1.2. Procedure

Children with autism were included in the study if they had received a clinical diagnosis of autism by a licensed and experienced psychologist or physician. To confirm the diagnosis for the present study, the parents of the children with autism completed the Autism Diagnostic Interview-Revised (ADI-R), a standardized, semi-structured, investigator based interview for caregivers of children with autism (Lord, Rutter, & LeCouteur, 1994). A study investigator who was research reliable on the ADI-R completed all of the interviews; all 35 children with autism met criteria for autism on each of the three domains (Language/Communication; Reciprocal Social Interactions; and Restricted, Repetitive, and Stereotyped Behaviors and Interests) according to parent responses on the ADI-R.

Cognitive and language assessments. All participants completed the Stanford-Binet Intelligence Scale, 4th edition (Thorndike, 1977). The Stanford-Binet scoring provided both MA and Full Scale IQ for both the autism and typically developing samples.

We assessed each child's ELA and Receptive Language Age with the Reynell Developmental Language Scales (Reynell, 1977). One child in the autism sample was at the floor of the Reynell for ELA (below 12 months). The participant correctly responded to some items (4 items), but the age equivalency was below the basal level for the language assessment used. None of the participants in the autism sample experienced *ceiling effects* for ELA. None of the children in the typically developing sample had *floor* or ceiling effects for ELA on the Reynell Developmental Language Scales.

Matching procedure. We divided the sample of children with autism into four groups based on expressive language age, as measured on the Reynell Developmental Language Scales (1977; see Table 1). The first group (Group 1) consisted of children with an ELA between 12 and 20 months. The second group (Group 2) consisted of children with an ELA between 21 and 30 months. The third group (Group 3) consisted of children with an ELA between 31 and 46 months. The last group (Group 4) included children with an ELA between 47 and 64 months. We grouped the typically developing children based on the same ELA parameters (see Table 1).

An independent samples *t*-test revealed no group difference between the typically developing sample and the sample of children with autism on expressive language age, receptive language age, or mental age, as was to be expected given their matching on ELA. The matched ELA groups (typically developing sample as compared to the sample of children with autism) did differ in terms of CA ($t = 8.11$, $p < 0.01$), and Full Scale IQ ($t = -6.63$, $p < 0.01$) (see Table 1 for details on the participant characteristics).

The Early Social-Communication Scales (**ESCS**). The ESCS is an assessment designed to elicit nonverbal communication (Siebert, Hogan, & Mundy, 1982). In this semi-structured, videotaped interaction, a child and an experimenter sat facing each other at a small table. A set of toys including balloons, wind-up toys, glasses, a hat, comb, book, ball, and car were in view but out of the child's reach. Colorful posters hung on the walls of the room. The experimenter presented and activated the toys one at a time. The experimenter also intermittently pointed and looked at the wall posters, made simple requests of the child such as "give it to me," and presented the child with social games and turn-taking opportunities. Assessors counterbalanced the presentation of materials within the ESCS. The period of interaction with each child was approximately 20 min.

Table 1
Study 1: Participant characteristics.

ELA ranges (months)	Group 1 12–20	Group 2 21–31	Group 3 32–46	Group 4 47–64	Total 12–64
Autism sample					
N (sample size)	*n* = 8	*n* = 11	*n* = 7	*n* = 9	*N* = 35
CA					
M (*SD*)	47.88 (9.95)	50.18 (10.24)	57.71 (11.18)	59.78 (11.80)	53.63 (11.45)
Range	38–70	36–68	37–67	40–72	36–72
SB MA					
M (*SD*)	27.25 (6.52)	32.45 (6.58)	45.29 (10.42)	57.78 (13.86)	40.34 (15.23)
Range	15–37	24–45	32–57	42–80	15–80
SB Full Scale IQ					
M (*SD*)	61.13 (14.76)	69.55 (12.97)	80.14 (15.72)	98.44 (17.29)	77.17 (20.23)
Range	32–76	51–96	58–100	68–119	32–119
RDLS ELA					
M (*SD*)	14.88 (3.09)	24.00 (2.28)	36.71 (5.28)	57.11 (7.52)	32.97 (16.79)
Range	12–20	21–28	31–44	47–64	12–64
RDLS Rec. Lang. Age					
M (*SD*)	14.63 (4.27)	22.64 (5.48)	34.14 (5.34)	50.44 (12.40)	30.26 (15.27)
Range	10–22	11–31	26–42	37–70	10–70
Typically developing sample					
N (sample size)	*n* = 4	*n* = 4	*n* = 5	*n* = 5	*N* = 18
CA					
M (*SD*)	26.00 (6.38)	23.50 (3.70)	27.80 (5.36)	36.40 (11.06)	28.83 (8.42)
Range	21–35	20–28	24–37	24–52	20–52
SB MA					
M (*SD*)	26.25 (6.95)	30.50 (5.97)	36.60 (5.68)	47.20 (11.12)	35.89 (10.86)
Range	20–36	24–38	28–43	30–57	20–57
SB Full Scale IQ					
M (*SD*)	99.00 (13.09)	120.75 (5.97)	112.60 (8.91)	114.60 (10.46)	111.94 (12.80)
Range	88–118	113–140	102–125	104–129	88–140
RDLS ELA					
M (*SD*)	19.00 (0.82)	26.75 (2.50)	38.00 (4.74)	52.60 (5.27)	35.33 (13.53)
Range	18–20	24–30	34–46	48–60	18–60
RDLS Rec. Lang. Age					
M (*SD*)	24.75 (4.86)	34.25 (4.65)	35.60 (3.58)	51.60 (5.18)	37.33 (10.84)
Range	20–31	30–40	30–40	47–60	20–60

Note: All ages presented in months. SB is the Stanford-Binet, 4th edition. RDLS is the Reynell Developmental Language Scales.

Independent coders scored the videotaped interaction. The coders overlapped coding on 20% of the sample, and reliability was estimated using a two-way mixed effects model (consistency definition) represented by a single rater intraclass correlation coefficient (ICC) value, with an ICC value greater than .75 considered high reliability (Burdock, Fleiss, & Hardesty, 1963). We report these coefficients after each variable below. The major joint attention variables of interest for this study included frequency of both initiations and responses of JA behaviors. Initiations included coordinated looks (ICC = .77), pointing (.78), and showing (.79). Responses included responding to experimenter points (.81) and following gaze (.83). The average ICC for joint attention initiations was .79, and for joint attention responses, the average ICC was .82. The variables for requesting included reaching (.82), giving (.84), and pointing (.80). The average ICC for requesting initiations was 0.82. The above ICCs indicate that the assessment of skills by different observers was reasonably consistent.

3.2. Results

3.2.1. Determination of scores for each communicative form

In order to examine use of specific requesting and joint attention skills with increasing expressive language age, we examined each communicative form separately for both children with autism and typically developing children. Coders computed the frequencies for each of the joint attention and requesting variables for each participant. In order to examine the emergence of specific communicative forms, we recoded each form as a categorical variable, with *skill not present* = 0 and *skill present* = 1. Using previously accepted criteria, a skill was considered to be *emerged* when at least one-third of the children in a specific expressive language age group demonstrated the skill at least once (Snow, Pan, Imbens-Bailey, & Herman, 1996). We applied these criteria to each group (typically developing children and children with autism) separately. We report the within-group results for the typically developing children in a descriptive manner to confirm the existing normative data and to obtain a framework of normative joint attention and requesting development.

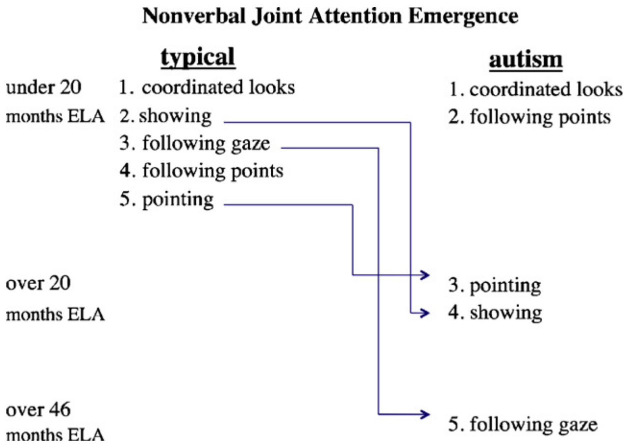

Fig. 1. The sequence and timing of joint attention skill emergence in typical children and children with autism. Typical development based on the following references, in addition to data in this study: Bakeman and Adamson (1984), Bates et al. (1975, 1979, 1987), Bruner (1983), Butterworth (1991), Crais, Douglas, and Campbell (2004), Leung and Rheingold (1981), Morisette et al. (1995), and Murphy and Meisser (1977).

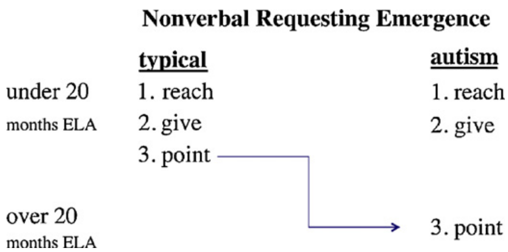

Fig. 2. The sequence and timing of requesting emergence in typical children and children with autism.

3.2.2. Skill emergence in typical children

The timing of acquisition: nonverbal joint attention and requesting forms. As supported by the literature, all of the nonverbal skills coded in the present study emerged in the typically developing sample of children by 18 months ELA; at least one-third of the children in each language age group (Groups 1–4) demonstrated all of the gestures. All of the typically developing children used the requesting skills of reaching, giving, and pointing (Fig. 2). In the joint attention function, the percentage of children following gaze (83%), following points (100%), using coordinated joint looks (94%), showing (89%), or pointing (72%) was similar across language levels (see Fig. 1).

The sequence of acquisition. Figs. 1 and 2 show the sequence of skill emergence for each of the communicative categories (joint attention and requesting, respectively). The data from this study, as well as from normative literature, appears to support the construction of each sequence of skill emergence.

3.2.3. Skill emergence in children with autism

The timing of acquisition. After close examination of each plot in the sample of children with autism, it was determined that (1) certain communicative forms were not present at specific language ages; (2) the frequency of communicative forms varied by expressive language age; and (3) differences in either emergence or frequency of communicative forms seem to occur at cutoffs between the expressive language age groups. Therefore, we examined each communicative form by group (Groups 1–4) using chi-square analyses, explained below by category.

Nonverbal joint attention (**responsive**). Children at all language ages followed another person's points (proximal and distal). The percentage of children who followed points (89%) at each language age (Groups 1–4) was not significantly different. However, only children with ELAs above 47 months (Group 4) followed another's gaze ($\chi^2 = 13.05$, $p < 0.01$). In addition, of the children in Group 4, only 44% demonstrated this skill (see Table 2 and Fig. 1)

Nonverbal joint attention (**initiated**). Table 2 and Fig. 1 show that children of all language ages engaged in coordinated joint looks. The proportion of children who engaged in 'coordinated looks' (mean of 97%) in each group (Groups 1–4) was similar. Only children with ELAs above 20 months (Groups 2, 3 and 4) engaged in pointing ($\chi^2 = 10.61$, $p = 0.01$, with Groups 1 and 2 significantly lower than Groups 3 and 4). In addition, no children under 20 months ELA engaged in showing to share attention. However, so few children in each cell used the skills that statistical analysis was not able to yield significant differences between cells. For children over 20 months ELA (Groups 2–4), the mean percentage who engaged in showing was 47%, pointing was 58%. Within each of these forms, the proportion of children using the skill did not vary by expressive language age.

Table 2
Study 1: Children with autism – Proportion of children engaging in nonverbal gestures.

	Group 1 $n = 8$	Group 2 $n = 11$	Group 3 $n = 7$	Group 4 $n = 9$
ELA group range (months)	12–20	21–30	31–46	47–64
Actual ELA range	12–20	21–28	31–44	47–64
Joint Attention – Responsive Forms				
Follows gaze (%)	0	0	0	44
Follows point (%)	75	81.8	100	100
Joint Attention – Initiated Forms				
Coordinated Joint Looks (%)	87.5	100	100	100
Show (%)	0	46	29	67
Point (%)	0	36	71	67
Requests – Initiated Forms				
Reach (%)	75	90.9	100	77.8
Give (%)	100	100	100	100
Point (%)	0	64	100	100

Nonverbal requesting. Table 2 and Fig. 2 show that children of all language ages displayed reaching and giving for objects with a requesting function. The percentage of children engaging in reaching (mean of 86%) and giving to request (mean of 100%) was similar across the groups. However, only children with ELAs above 20 months used pointing to request objects ($\chi^2 = 16.73$, $p < 0.01$, with Group 1 significantly lower than Groups 2–4). Of these children (above 20 months ELA), the proportion of children across ELA groups using a point gesture (88%) was not significantly different.

The sequence of acquisition. One of the primary aims of this study was to determine if children with autism acquire joint attention and requesting skills in a similar sequence to typical children. Scaling methods have been widely used to validate the ordinality of sequences in cross-sectional studies (Edwards, 1957; Green, 1956; Guttman, 1950). The method used in this paper is the Goodenough Edwards Scaling Technique (Edwards, 1957), which is a modification of Guttman's (1950) version. The procedure discerns whether subjects, in response to a series of items rank-ordered by difficulty, succeed to a certain point and fail all subsequent items. The Goodenough Edwards technique counts errors based upon deviations from perfect reproducibility. This method is more rigorous than Guttman's scaling method as it protects against spuriously high levels of reproducibility. The procedure yields a coefficient of reproducibility (R), which is a measure of the extent to which a respondent's scale score is a predictor of a response pattern. An ordinal scale is any value greater than 0.9. The closer the value is to 1.00, the more invariant the ordinal sequence. In addition, a coefficient of scalability (Q) above 0.6 indicates that the scale can be considered unidimensional and cumulative.

Based on the data we obtained a hypothesized sequence of skill emergence for each communicative category (see Table 2). We then tested the hypothesized sequences for each communicative category using the Goodenough Edwards cumulative model of scalogram analysis. We calculated a coefficient of reproducibility 'R' and a coefficient of scalability 'Q' for each sequence. The results are as follows for the sequences shown below in Figs. 1 and 2: nonverbal joint attention: [$R = 0.97$; $Q = 0.78$], nonverbal requesting: [$R = 0.98$; $Q = 0.84$]. Therefore, both communicative categories were a valid scale. The sequence of skill emergence for children with is shown in Figs. 1 and 2.

Other predictors of joint attention and requesting skills. We also considered the contribution of developmental indices, other than expressive language age, in relation to communicative development. MA ($r = 0.84$, $p < 0.001$), CA ($r = 0.44$, $p < 0.01$), and Full Scale IQ ($r = 0.72$, $p < 0.001$) were highly correlated with ELA. A stepwise multiple regression was run for each communicative category (e.g., nonverbal requests) as an outcome variable with MA, full scale IQ and CA as the predictors, and ELA as a covariate. For each category (except nonverbal requesting), MA emerged as the only significant predictor for two skills in this area: nonverbal responsive joint attention ($F = 11.09$, $p < 0.01$, $R^2 = 0.25$, VIF = 1, tolerance = 1) and nonverbal initiated joint attention ($F = 30.01$, $p < 0.00$, $R^2 = 0.47$, VIF = 1, tolerance = 1). In the case of nonverbal requesting, none of the hypothesized variables emerged as significantly predictive when ELA was used as a covariate. These analyses indicated that for the most part, ELA should be considered along with MA when examining the developmental trajectory of nonverbal and verbal joint attention and requesting forms.

4. Study 2

4.1. Method

4.1.1. Participants

Study 2 examined nonverbal joint attention and requesting skill emergence in 15 children with autism, seen at four time-points just over a one-year period. The 15 participants were part of the control group of an IRB approved randomized controlled trial (RCT) experimental treatment study (Kasari, Freeman, & Paparella, 2006). (For greater detail on consenting, see Kasari et al., 2006, and Kasari, Paparella, Freeman, & Jahromi, 2008.) Thus, these participants did not receive any targeted joint attention interventions. In the original study, there were 17 control group participants; however, one participant was missing Time 1 data pertinent to this study, and one participant declined participation for the one year follow up assessments (Time 4), thus we report on one year longitudinal data for 15 of the original 17 children.

The participants met the following inclusion criteria: a diagnosis of autism on the Autism Diagnostic Interview-Revised (ADI-R; Lord et al., 1994), and the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 1999), no seizure disorder or additional medical diagnoses (e.g., genetic syndromes), between 36 and 48 months CA at the beginning of the study (Time 1), and accessible for follow-ups (e.g., no international families). The sample consisted of mostly males ($n = 12$), 9 children were Caucasian, 2 were African American, 3 were Asian American and 1 child was of a mixed ethnicity. The sample had highly educated mothers ($n = 9$) who had completed college (see Kasari et al., 2006, for greater detail). We obtained informed consent for all participants at the outset of the original RCT experimental treatment in accordance with UCLA Institutional Review Board procedures and regulations.

4.1.2. Procedure

Testers who were independent of the treatment staff and blind to child group assignment administered all assessments. Before beginning the RCT study (Time 1), children were assessed with the ADOS (Lord, Rutter, DiLavore, et al., 1999; Lord, Rutter, & LeCouteur, 1999), and parents were administered the ADI–R (Lord et al., 1994) in order to validate the clinical diagnosis of autism. Each child completed a battery of assessments, including the Mullen Scales of Early Learning (Mullen, 1989), the Reynell Developmental Language Scales (RDLS) (Reynell, 1977), and the Early Social-Communication Scales (ESCS; Siebert et al., 1982). Parents also completed a demographic questionnaire regarding background characteristics (ethnicity, maternal education). During the 5–6 week period, all of the children attended the same hospital day treatment early intervention program (EIP). The program consisted of 30 h of treatment per week, primarily applied behavior analysis, and did not focus on joint attention development. Since all children reported in this paper were part of the control group, none participated in any active targeted treatment as part of the RCT (Kasari et al., 2006). Each participant repeated several assessments (RDLS and ESCS), after approximately 2 months (Time 2), at 8 months (Time 3) and then again at 14 months (Time 4). At Time 4, each participant also completed the Mullen Scales of Early Learning. Developmental characteristics of the participants at each time-point are presented in Table 3.

The Early Social-Communication Scales (**ESCS**). This procedure was repeated at all four time-points (Time 1, Time 2, Time 3, and Time 4). See the description in Study 1 for detail on the procedures, coding, and reliability for the ESCS.

Assignment to language groups. As in Study 1, we examined children's skills in relation to their ELA on the Reynell Developmental Language Scales at four time points (Time 1–4; see Table 3). We used the same grouping parameters based on ELA levels as in Study 1. None of the participants in this sample experienced "floor" or "ceiling" effects on the RDLS for ELA. As in Study 1, the first group had an ELA between 12 and 20 months; the second group had an ELA between 21 and 30 months, the third between 31 and 46 months, and the last between 47 and 64 months.

4.2. Results

4.2.1. The timing of acquisition: longitudinal

Nonverbal joint attention (**responsive**). We list the results of the longitudinal sample in Table 4. As in Study 1, all children followed another person's points by 20 months ELA. Although three children attained an ELA of over 47 months by Time 4, none of them followed another's gaze at any point. However, two other children in the study followed another's gaze much earlier than predicted - one at an ELA of 16 months, the other at an ELA of 18 months. It is notable however, that these were single occurrences, each instance observed at Time 2 and not observed again at Time 3 or Time 4; this was an anomaly relative to the frequency and stability of other observed skills. An overview of responsive joint attention emergence is provided in Fig. 1.

Nonverbal joint attention (**initiated**). All children engaged in coordinated joint looking. One-third of the sample first displayed pointing at an expressive language age between 20 and 30 months. An analysis of the children who did not meet the hypothesis revealed that 5 children displayed pointing at earlier ages, and one should have developed pointing but did not. Of the 5 children who displayed pointing at earlier ages, 3 of the children did so immediately before entering into ELA Group 2 (21–30 months of age). For example, one participant displayed pointing at Time 2, while in Group 1 (ELA 12–20 months), and entered into Group 2 (ELA 21–30 months) at Time 3. This might suggest that the development of the gesture

Table 3
Study 2: Participant developmental scores by time point, mean (*SD*).

	Time 1 (Month 0)	Time 2 (Month 2)	Time 3 (Month 8)	Time 4 (Month 14)
CA	41.27 (4.70)	43.07 (5.11)	49.87 (5.36)	57.40 (5.12)
MSEL MA	22.60 (9.59)	–	–	33.73 (14.67)
MSEL DQ[a]	54.01 (22.48)	–	–	60.08 (26.61)
RDLS receptive				
Language age	18.40 (8.92)	19.80 (10.84)	25.73 (15.35)	28.40 (15.54)
RDLS ELA	20.13 (7.94)	22.13 (9.30)	25.27 (11.62)	29.00 (13.44)

Note. All "age" scores presented in months. Mental age based on Mullen Scales of Early Learning; Receptive and Expressive language ages based on Reynell Developmental Language Scales.
[a] Developmental Quotient was determined by the formula (MA/CA) × 100.

Table 4
Study 2: Proportion of children engaging in nonverbal gestures.

	Time 1 (Month 0)	Time 2 (Month 2)	Time 3 (Month 8)	Time 4 (Month 14)
ELA 12–20 months	*n* = 9	*n* = 8	*n* = 6	*n* = 4
Joint Attention – Responsive Forms				
Follows gaze (%)	0	25	0	0
Follows point (%)	100	75	83.3	100
Joint Attention – Initiated Forms				
Coordinated Joint Looks (%)	77.8	100	83.3	75
Show (%)	11.1	0	0	0
Point (%)	11.1	37.5	0	50
Requests – Initiated Forms				
Reach (%)	88.9	87.5	83.3	100
Give (%)	88.9	100	83.3	75
Point (%)	11.1	37.5	33.3	0
ELA 21–30 months	*n* = 4	*n* = 5	*n* = 3	*n* = 5
Joint Attention – Responsive Forms				
Follows gaze (%)	0	0	0	0
Follows point (%)	100	100	100	100
Joint Attention – Initiated Forms				
Coordinated Joint Looks (%)	100	100	67.7	80
Show (%)	75	40	0	0
Point (%)	75	80	67.7	0
Requests – Initiated Forms				
Reach (%)	100	80	100	80
Give (%)	100	100	100	80
Point (%)	100	80	100	80
ELA 31–46 months	*n* = 2	*n* = 2	*n* = 5	*n* = 3
Joint Attention – Responsive Forms				
Follows gaze (%)	0	0	0	0
Follows point (%)	100	100	100	100
Joint Attention – Initiated Forms				
Coordinated Joint Looks (%)	100	100	100	100
Show (%)	50	0	20	33.3
Point (%)	100	100	100	66.7
Requests – Initiated Forms				
Reach (%)	100	50	80	100
Give (%)	100	100	100	100
Point (%)	100	100	60	100
ELA 47–64 months	*n* = 0	*n* = 0	*n* = 1	*n* = 3
Joint Attention – Responsive Forms				
Follows gaze (%)	–	–	0	0
Follows point (%)	–	–	100	100
Joint Attention – Initiated Forms				
Coordinated Joint Looks (%)	–	–	100	100
Show (%)	–	–	0	33.3
Point (%)	–	–	100	100
Requests – Initiated Forms				
Reach (%)	–	–	100	66.7
Give (%)	–	–	100	100
Point (%)	–	–	100	100

Note: Percentage of children with autism engaging in nonverbal gestures for Study 2. Percentages are shown for the four different ELAs.

preceded development in expressive language (refer to Fig. 4 for development of joint attention skills by change in ELA group). The remaining 2 children displayed pointing at Time 4, and no other time during the study. Fifty-seven percent of the sample demonstrated showing for joint attention when they displayed reaching 20 months ELA. Only one child demonstrated the skill earlier than predicted (at an ELA of 14 months), but did not display the skill again during the study. The remainder of the sample did not demonstrate showing even at later ELAs. An overview of initiated joint attention emergence is provided in Table 4 and Fig. 1.

Nonverbal requesting. All of the sample displayed reaching and giving for objects under 20 months ELA, as predicted. One-third ($n = 5$) of the children displayed pointing to request, as predicted, between 20 and 30 months ELA. Five children displayed pointing earlier than expected (14–18 months ELA), and one displayed pointing later than expected (at 35 months ELA). As with the initiation of joint attention pointing, 3 of the participants who displayed pointing early, moved from ELA Group 1 to ELA Group 2 by the next time point in the study. This also may suggest that demonstration of advanced requesting gestures might precede development in expressive language (see Fig. 5 for development of requesting skills by change in ELA group). Two of the participants demonstrated pointing to request early on, and did not display it again during the study (see Fig. 2).

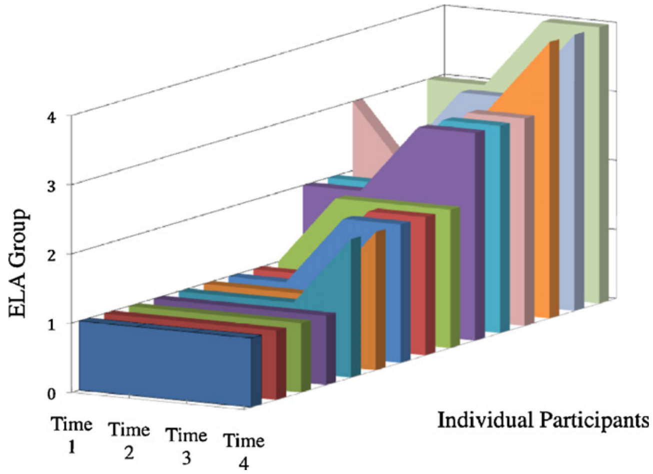

Fig. 3. Change in ELA groups for Study 2 over time. The figure depicts each of the 15 individual Study 2 participants over time (Time 1–4). The ELA group (1–4) is depicted on the vertical axis. Participants towards the front of the graph remained in ELA Group 1 (12–20 months ELA) across the study, while the last participant started in ELA Group 3 (21–30 months ELA) and moved to ELA Group 4 (47–64 months ELA).

Language group changes over time. We examined the participants' ELA group membership over time (see Fig. 3). On average, participants gained 8.87 months in ELA over time ($SD = 6.91$). The range of change varied greatly, some participants did not change at all whereas one participant gained 22 months ELA. The median level of change in ELA group was an increase of 1 level; 53% or 8 participants moved up at least one ELA group level. Twenty percent, or 3 participants, increased 2 ELA group levels. Five of the participants (33%) did not change their ELA group over time – 4 remained in Group 1 (12–20 months) and 1 participant remained in Group 3 (31–46 months). Of these 5 participants, the 1 participant who remained in Group 3 throughout did demonstrate an increase of 12 months ELA over the course of the study; 3 participants in Group 1 demonstrated no ELA change, and 1 participant demonstrated an increase of 1 month ELA over time.

Using the change in ELA group over time, we also looked at the development of joint attention skills over time (see Fig. 4). Four distinct profiles emerged from examining change in ELA grouping over time. Four participants depicted in the first profile remained in Group 1 (12–20 months ELA) throughout the study; all of these participants demonstrated the earliest forms of joint attention skills (coordinated joint looking and following points) during the study. Two of the participants did display pointing, and one participant demonstrated showing. The next profile was composed of participants who moved from ELA Group 1 (12–20 months ELA) to ELA Group 2 (21–30 months ELA) during the study. This group of four participants all demonstrated the earliest forms of joint attention skills (coordinated joint looking and following points). Two participants in this group did demonstrate following gaze, at one time point only. Three of the four also initiated pointing during the

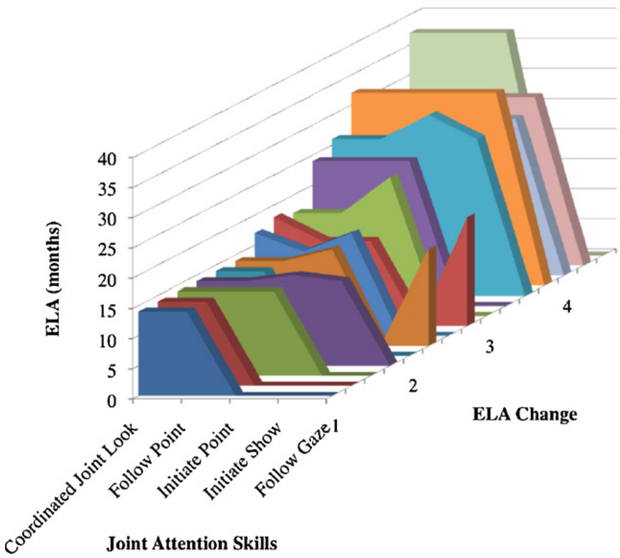

Fig. 4. Emergence of joint attention skills for Study 2 over time, by ELA. The figure outlines when individual joint attention skills (listed on the horizontal axis) were first observed during Study 2, at a given ELA (listed on the vertical axis) for each participant in Study 2. Participants ordered (on the depth axis) by change in ELA group over the course of the study.

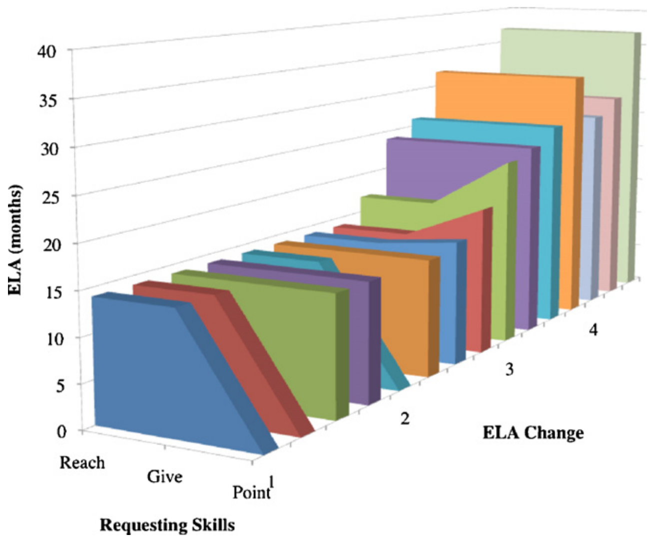

Fig. 5. Emergence of requesting skills for Study 2 over time, by ELA. The figure outlines when individual requesting skills (listed on the horizontal axis) were first observed during Study 2, at a given ELA (listed on the vertical axis) for each participant in Study 2. Participants ordered (on the depth axis) by change in ELA group over the course of the study.

study. The third profile of 4 participants moved from ELA Group 2 (21–30 months ELA) to ELA Group 3 (32–46 months ELA) over the course of the study. One participant remained in ELA Group 3 throughout most of the study, at Time 2 he did move down to ELA Group 2 before returning to ELA Group 3. Another participant moved from ELA Group 1 to ELA Group 3 over the course of the study. Among this profile, all participants displayed coordinated joint looking, following points, and pointing. Half of the participants ($n = 2$) also initiated showing. The last profile included three participants who entered ELA Group 4 (47–64 months ELA) during the course of the study. One participant moved from ELA Group 3 to ELA Group 4, and 2 of the participants moved from ELA Group 2 to ELA Group 4 over the course of the study. Among these participants, all demonstrated coordinated joint looking, following points, and pointing. Two-thirds ($n = 2$) initiated showing.

We completed a similar comparison for requesting skills (see Fig. 5). All of the participants displayed reaching and giving during the study. All but 3 of the participants displayed pointing to request as well. Of the three participants who never displayed pointing, 2 were in the lowest ELA group throughout the study (ELA Group 1, 12–20 months ELA), and 1 was in Group 1 for the majority of the study, but did emerge in ELA Group 2 (21–31 months) towards the end of the study. Two of the participants who moved from ELA Group 2 to 3 (32–46 months ELA) did learn to point over the course of the study. Of participants who started and ended the study with the highest ELAs all emerged with every measured requesting skill very early in the course of the study.

4.2.2. The sequence of acquisition

Similar to Study 1, the method used to test the hypothesized sequence of skill emergence for nonverbal requesting and joint attention skills was the Goodenough Edwards cumulative model of scalogram analysis (Edwards, 1957). We calculated a coefficient of reproducibility '*R*' and a coefficient of scalability '*Q*' for each sequence. The results are as follows for the sequences shown in Fig. 1: nonverbal joint attention [$R = 0.91$; $Q = 0.76$] and nonverbal requesting [$R = 1$; $Q = 1$]. Therefore, both communicative categories appeared to represent a valid scale, and exactly reproduced the sequence found in Study 1.

5. Discussion

The purpose of these studies was to determine whether the timing and sequence of joint attention and requesting skill acquisition in children with autism differs from those of typically developing children by using both a cross-sectional sample (Study 1) and a longitudinal sample (Study 2). Most striking was that children with autism acquired joint attention skills in a different sequence than typical children (see Fig. 1). The responsive skill of following gaze, which emerged approximately mid-sequence in typical children, was the last nonverbal form to emerge in children with autism. Another skill that emerged sequentially later than the typical group was showing.

In one other study that sequenced the order in which communication skills emerged in young children with autism, Carpenter, Pennington, and Rogers (2002) studied 12 young children with autism (mean verbal mental age = 26.7 months, range 15.5–45 months). They found that two-thirds of their sample acquired skills in the following atypical order: follow behavior (as measured by imitation) → share attention (measured by coordinated joint looks) → direct behavior (measured by pointing or giving to request) → follow attention (measured by following another's point or gaze) → direct attention (measured by showing, pointing or giving to share attention). In our study, we examined this question in a larger autism sample and isolated the emergence of each skill for greater specificity (in contrast to collapsing skills into communicative categories). In some ways, our results are similar to the joint attention skill sequence reported by Carpenter et al. (2002). As in our data, shared attention (coordinated joint) looks emerged first. Carpenter et al. (2002) reported "follows attention" as emerging next. Our results indicate following another's points as the second skill to emerge. The last skill in the Carpenter et al. (2002) sequence was the communicative category of "directing attention," which included the skills of showing and pointing, two skills that we measured and found to emerge after follow another's points. A notable difference between our results and those of Carpenter et al. (2002) was the order in which follow gaze emerged. They placed it second in the sequence in the category of following attention. In our data, this skill was the last to emerge in the sequence. The difference may be attributed to the procedure used in the Carpenter et al. (2002) study in that they gave children credit for "attention following" if they either followed points or followed gaze. Thus, their method did not pinpoint emergence of specific (or single) skills. Indeed they report that 17% of their sample passed the following gaze test; short of the one third criterion we used to determine a skill as considered emerged. Indeed, our results are similar to theirs in that children with autism rarely followed another's gaze in both our cross-sectional and longitudinal samples. In sum, the sequence of skill emergence as depicted in Fig. 1 suggests an atypical developmental trajectory of nonverbal joint attention skill emergence in children with autism. In contrast, the sequence of skill emergence for nonverbal requesting mirrored the sequence of typically developing children, i.e., reaching, giving, and pointing emerged in that order for both groups. Indeed, the sequences of skill emergence for both nonverbal joint attention and nonverbal requesting gestures were evident in the cross-sectional group data from study 1 and then supported by individual profiles of skill emergence examined longitudinally in Study 2.

Although the individual profiles mapped on the proposed order with significance, an examination of the anomalies may suggest several interesting research avenues. The implications on language development should be further researched for those children developing skills somewhat earlier than what would be expected (e.g., following gaze). For those children who never displayed a skill, or who displayed advanced skills only once and in an atypical sequence, the question of motivation and engagement may become relevant. One could argue that these individual children (who show a skill so infrequently) are actually capable but do not use these important preverbal joint attention skills. Additional longitudinal studies could shed further light on the relationship between their use of joint attention skills and language emergence.

Of further interest, beyond the sequence of skill acquisition was the timing of skill emergence. For children with autism, several joint attention skills emerged developmentally later than in the normative model (see Fig. 1). Whereas typically developing children follow another's gaze by 20 months ELA, the children with autism in our samples rarely demonstrated this skill. In study 1 it was only evident in less than half of the children over 46 months ELA. In the longitudinal sample (Study 2) two children followed gaze. In these children the skill was evident under 20 months ELA (similar to typically developing children). However, each child demonstrated the skill only once, at Time 2, and then never demonstrated it again, suggesting that the skill was extremely unstable and its true emergence questionable (as stated previously, this pattern was unique to the following gaze skill and not seen with the other skills). It is not surprising that *following gaze* was rarely evident in the children with autism and that it appeared to emerge in a stable pattern much later that what would be predicted. Its more subtle nature requires not only a keen awareness of other, but also requires the ability to easily change focus of attention, a skill not as readily accomplished by children with autism (Swettenham et al., 1998). Another consideration may be that children with autism tend to focus more on people's mouths than on their eyes (Joseph, 2001; Klin, Jones, Schultz, & Volkmar, 2003). Thus, they may miss important cues of attention.

The other gesture that emerged notably later than expected was showing, which only appeared in children with an ELA of over 20 months. When showing did emerge, only about half of the children in both autism samples demonstrated the skill. Indeed, in the longitudinal sample, approximately 40% of the children did not show at all, even as their ELA advanced beyond 30 months. These results reflect findings of existing studies that reported impairments in shows (Mundy et al., 1990, 1994). It may be that children with autism experience difficulty distinguishing between different functional subtleties of the physically similar gestures of giving, requesting and showing. While the more straightforward gesture of giving to request seems mostly unhampered in autistic development, the more ambiguous and intersubjective skill of showing appears much later in its emergence than initially expected given previous research.

The timing of emergence for pointing in the autism groups seems less clear. In the cross-sectional sample, pointing emerged in children with autism over 20 months ELA regardless of whether it was to request or to share attention. This was consistent with two existing studies that found joint attention pointing to be impaired in children under 20 months MA (Mundy et al., 1990, 1994). Of the children with autism who were followed longitudinally, pointing (for the purpose of sharing or requesting) emerged over 20 months ELA in approximately two thirds of the sample but before 20 months ELA in one third of the children. Thus, it seems that, at least in these two samples of children with autism, pointing emerged somewhat later than expected; but it is less clear that an ELA of 20 months can be used as a developmental marker for its emergence. It is interesting, however, that the function of the pointing gesture did not appear to differentiate, when it emerged, between pointing to show or share and pointing to request. This lends support to the argument made by Tomasello, Carpenter, and Liszkowski (2007) that the requesting and joint attention functions are very closely linked. A joint attention point lends itself to social cognition, whereas receiving social help motivates a requesting point. Thus, it should not be surprising that when a child begins to point to make requests, he or she begins to point at about the same time for sharing purposes as well. Additionally, the longitudinal data on pointing hinted that development of pointing might precede the development of expressive language. A group of children demonstrated pointing earlier than expected in terms of ELA, but then showed growth in ELA at the next visit. While the data are limited to make a strong argument, this is certainly an interesting finding and has implications for future language intervention.

Despite many of the above skills emerging later than what would be expected, it is worth noting that even the youngest ELA children in this study engaged in basic levels of joint attention such as coordinated looks. Furthermore, all forms of joint attention and requesting do seem to emerge in children with autism, though they may appear much later than in typical children. Of particular interest is that children with autism do not show a complete absence of joint attention skills. Rather, they use different types of joint attention and requesting skills depending on their level of development. Interestingly, twenty months ELA appears to be essential for the development of several nonverbal social communication skills. This confirms the possibility that some children with autism at low levels of functioning may not develop certain forms of joint attention.

Our findings, however, did not support several autism-specific hypotheses posed in the literature. Concerning joint attention, the hypothesis that all responsive joint attention skills precede initiated skills was not supported (Baron-Cohen, 1989; Mundy et al., 1994). Indeed, in this study, the responsive skill of following another's gaze emerged later than most initiated skills. This suggests that the specific type of skill determined its emergence and not whether it is responsive or initiated. With regard to requesting, the late emergence of pointing (relative to typically developing children) for the majority of children with autism does not support the idea that requesting gestures are unaffected in their development (Loveland & Landry, 1986; Mundy et al., 1986). However, our results do lend support to the view that requesting skills appear to be less affected for children with autism than their joint attention skills.

This study suggests some possible implications for intervention. It appears that a curriculum based on a normative developmental model for the emergence of requesting skills is mostly appropriate for use with children with autism. However, since children with autism acquired nonverbal joint attention skills in a sequence that differed from a normative model, this raises the question of whether a normative or non-normative (autism-specific) joint attention curriculum would be more likely to benefit children with autism. From an intervention perspective, since the skills of follow gaze and showing are particularly challenging for children with autism, it may be that these skills might require more targeted or more intensive intervention.

A limitation of this paper is that we measured communicative engagement within experimental assessments that provided a more structured environment than when such communication typically occurs. As such, data collected in a more naturalistic manner, such as a parent–child interaction, may be useful in determining if these findings generalize across different communicative contexts. Second, the sample sizes were quite small. Given the small inconsistencies between the two studies, particularly concerning pointing, a larger longitudinal sample might provide a more representative picture of the developmental emergence of these skills.

In summary, this study examined the emergence and development of joint attention and requesting skills in young children with autism across a wide range of language abilities in both cross-sectional and longitudinal study designs. Findings suggest that children with autism use different types of joint attention and requesting gestures depending on their level of development, and that the emergence of certain gestures within each function tends to emerge later that would be expected when compared to that of typically developing children. Results further suggest that, compared to typical children, nonverbal requesting gestures of children with autism tend to emerge in a mostly similar sequence. Nonverbal joint attention skills on the other hand, seem to emerge in a different sequence for children with autism.

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Appendix A. Coding definitions used for Study 1 and Study 2

Joint Attention	Communication that is for the purpose of sharing an object, picture, or event with another person.
Initiated Forms	Initiated forms must be displayed spontaneously by the child – without any prompting, or suggesting by the examiner.
Coordinated Joint Look	A three-point look initiated by the child. The child either looks from an object, to the examiner, then back to the object or from the examiner, to the object, then back to the examiner. This has to involve clear eye contact with the examiner, and the three-points must occur within 3 s.
Point	The child must initiate a clear point, by extending the index finger only (i.e., closed palm), to an object or picture. Both distal points (points to an object or picture more than 3 inches away) and proximal points (points to an object or picture within 3 inches without touching) were coded in this category. This could be completed with or without eye contact made with the examiner.

Show	A show is coded as an instance when the child holds up an object to the examiner for the purpose of sharing. The object must be clearly held up to the eye level of the examiner. This could be completed with or without eye contact made with the examiner.
Responsive Forms	Communication that is initiated, but in direct response to an action or communication by the examiner.
Follow Point	The child follows the point of the examiner. Both distal points (points to a picture or object more than 3 inches away) and proximal points (points to a picture in a book without touching the picture) were coded. Distal and Proximal points were collapsed for the present study.
Follow Gaze	The child follows the gaze of the examiner by making eye contact with the examiner, and following the examiner's gaze to an object or picture.
Requesting	Communication that is for the purpose of requesting an object, event, activity, or help.
Initiated Forms	Initiated forms must be displayed spontaneously by the child – without any prompting, or suggesting by the examiner.
Reach	The child clearly reaches towards an object by extending the arm, hand and fingers without touching the object. This could be accompanied with or without eye contact to the examiner.
Point	The child initiates a clear point, by extending the index finger only (i.e., closed palm), to a desired object. Both distal points (points to an object more than 3 inches away) and proximal points (points to an object within 3 inches without touching the object) were coded in this category. This could be accompanied with or without eye contact to the examiner.
Give	The child spontaneously gives an object to the examiner for the purpose of requesting help, or another request. This must be a clear give and does not include pushing an item in the general direction of the adult, or a give for the purpose of taking turns. This could be accompanied with or without eye contact to the examiner.

Bakeman and Adamson (1984); Kasari et al. (2006); Mundy et al. (1986, 1994).

Appendix B. Continuing education questions

1. Name 3 specific initiating gestures used to communicate for the purpose of joint attention.
2. Name 2 specific nonverbal responsive joint attention skills.
3. Do children with autism develop specific nonverbal requesting gestures in a similar or different sequence as compared to typically developing children?
4. Do children with autism develop specific nonverbal joint attention gestures in a similar or different sequence as compared to typically developing children?
5. Name 2 specific nonverbal joint attention skills that appear significantly impaired in children with autism relative to typically developing children.

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