Relationships Between Early Gestures and Later Language in Children With Fragile X Syndrome

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Abstract

Purpose—The authors hypothesized that significant positive relationships would exist between early gesture use and later language attainments in children with fragile X syndrome (FXS), as has been reported in studies with other populations.

Method—Participants were young children with FXS and limited expressive language (21 boys, 4 girls), divided into 2 subgroups based on the Childhood Autism Rating Scale (CARS; Schopler, Reichler, & Renner, 1988) scores. Data were collected when participants were about 2 years of age and again when they were about 5 years of age. Communication was assessed through the analysis of video samples obtained in the children's homes for both observation periods. Correlational analyses were completed between early prelinguistic communication and later verbal communication scores for all participants and for children with high (>30) versus low (<30) scores on the CARS.

Results—Although no significant relationships were found between prelinguistic gesture use and language outcomes for the group of children as a whole, significant negative correlations were found for the group of children who had high CARS scores.

Conclusions—These outcomes did not support the authors' initial hypotheses. It was concluded that extensive use of developmentally early gestures by children with FXS who also have many symptoms of autism may not be a positive indicator of later language.

Keywords

fragile X; gestural communication; autism spectrum disorders

Fragile X syndrome (FXS), which is caused by the mutation of a gene on the X chromosome, is the most common known cause of inherited intellectual disability. The level of disability resulting from FXS ranges from learning disabilities to severe mental retardation. FXS is also the most common known single-gene cause of autism. Delays in speech and language development are common symptoms of FXS (National Fragile X Foundation, 2006).

Research on the language development of children with FXS is fairly limited and historically has focused primarily on school-age children. The majority of children with FXS are still in the early stages of language development by the time they turn 3 years of age, and some may not be talking at all yet. Roberts, Hatton, and Bailey (2001) reported that a sample of 26 young boys with FXS used their first spoken words at 28 months of age, on average, with a range of 9–88 months, indicating a severe delay in the onset of spoken language among many children with FXS. Roberts, Mirrett, and Burchinal (2001) found that in

children with FXS, receptive language developed more quickly than expressive language, which developed at about one third of the rate of children without disabilities. Thus, expressive language is an area of particular concern for children with FXS, yet not much research has examined early stages of expressive language development in children with FXS or the relationships between early prelinguistic communication and language development.

Because males have only one X chromosome, they are usually more affected by FXS than females (Hagerman, 2007). Autism occurs in about 25%–33% of males and in about 5%– 15% of females with FXS (Hagerman, 2007). Philofsky, Hepburn, Hayes, Hagerman, and Rogers (2004) reported that children with FXS who also have autism have more severe receptive and expressive language impairments than children who have only FXS. Children with FXS who have more symptoms or more severe symptoms of autism may develop language differently from children with FXS who do not have autism. For example, there may be differences in the forms or functions of these subgroups' communication in addition to the known differences in severity of impairment. Such differences may affect how an interventionist approaches treatment with a particular child.

Because autism is known to affect the language abilities of children with FXS, it is important to consider the prelinguistic and early verbal communication characteristics of children with autism when examining the prelinguistic and early verbal communication of children with FXS. From very early in their development, children with autism show differences in their intentional communication. Babies who are later diagnosed with autism have been found to demonstrate major differences from typically developing babies, including a lack of joint attention behavior and an abnormal response to human faces and voices (Chawarska & Volkmar, 2005). Young children with autism rarely communicate to share focus or joint attention; however, they do communicate to express wants and needs (Wetherby et al., 2004). Stone, Ousley, Yoder, Hogan, and Hepburn (1997) reported that when compared with same age peers who had developmental delays and comparable mental ages and expressive vocabularies, 2- and 3-year-old children with autism demonstrated a decreased likelihood to point, show objects, or use eye gaze to communicate. Children with autism in this study also used less complex combinations of behaviors to communicate, and they were observed to request more often and comment less often than their matched peers. Children with autism also may develop maladaptive, unconventional, or idiosyncratic behaviors to communicate (Wetherby et al., 2004). Because of the nature of autism and its effects on language development, one needs to consider the variance in the presence and severity of symptoms of autism among children with FXS when studying this population's prelinguistic communication and later language development.

Research on prelinguistic communication necessarily includes an examination of gesture usage. On the basis of a seminal work by Bates and colleagues (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979), research has consistently documented a continuous development in communication, marked by early gestures and progressing into words and sentences (Volterra, Caselli, Capirci, & Pizzuto, 2005). By about 12 months of age, gestures become a primary means of communication for the typically developing child. Gestures including giving, showing, and reaching appear when children are about 8 months old, and pointing appears when children are about 12 months old (Brady, Bredin-Oja, & Warren, 2007; Crais, Day Douglas, & Cox Campbell, 2004). Recent investigations of typically developing children have found that early gesture use is predictive of later vocabulary development. Specifically, Rowe, Özçalıskan, and Goldin-Meadow (2008) reported that child gesture use at 14 months predicted receptive vocabulary at 42 months. Rowe et al. (2008) found that the number of child gesture types (i.e., different gestures), in particular, appeared to be strongly related to later vocabulary development. In addition, Rowe and

Goldin-Meadow (2009) reported that the effect of socioeconomic status on child vocabulary development at 54 months is partly mediated by children's gesture use at 14 months. Given the importance that gesture use plays in the language development of typically developing children, it is imperative that gesture use be considered in the language development of children with disabilities. In addition to considering the amount of gestures, Rowe et al.'s (2008) research indicates the importance of examining gesture types.

Pointing is one type of gesture that has received considerable attention from researchers. In typically developing children, pointing at distal locations has been shown to predict subsequent language development (Brooks & Meltzoff, 2008). That is, children who pointed during an assessment that was completed when children were 11 months old had significantly faster vocabulary development through 2 years of age than did children who did not point during the assessment. Butterworth and Morisette (1996) found that age of pointing onset predicts gesture use and sound comprehension at 14.4 months. Specifically, children who began pointing at a younger age produced more gestures and understood more animal sounds at age 14.4 months than children who began pointing later, which indicates that pointing may be an important predictor of receptive and expressive communication development. Pointing appears to be crucial in the transition between communicating about the immediate environment and communicating about distal events, as mature forms of pointing allow a child to communicate about distant objects. In addition, pointing and other gestures such as waving are often used to convey more social messages.

Little research has been devoted to gesture use or other prelinguistic communication in children with FXS; however, one study by Roberts, Mirrett, Anderson, Burchinal, and Neebe (2002) found that a sample of 22 boys with FXS between 21 and 77 months with a developmental age younger than 28 months demonstrated a significant delay in gesture development. Because boys with FXS typically have developmental delays and often have symptoms of autism (Abbeduto & Murphy, 2004), the observed delays in gesture development may have been related to overall development of the children and/or degree of autism symptoms, although these relationships were not specifically tested. Delayed or deficient development of gestures, particularly social gestures, is a primary prelinguistic characteristic of children with autism (American Psychiatric Association, 2000). Children with autism have been found to have large deficits in their use of conventional gestures when compared with typically developing children and moderate deficits compared with children who have developmental delays (Wetherby, Watt, Morgan, & Shumway, 2007). In addition, autism has been found to be associated with a decreased variety of social interaction gestures used in 9- to 12-month-old infants (Colgan et al., 2006). Delayed onset and decreased variety of gestures is generally viewed as an early indication of language delays reported in older children with FXS (Brady, Bredin-Oja, & Warren, 2007).

In summary, the available information on gesture development in children with or without developmental disabilities suggests that use of gestures is an important step in early communication development. Gesture use is valuable for enabling an individual to communicate wants, needs, and interests, and delayed gesture use is consistent with an overall delay in communication development. In terms of the continuum of communication and language development, however, the role of gesture use may be more complicated to understand. For example, reliance on gesture communication, primarily nonsocial gestures, for an extended period of time may indicate that a child is less likely to transition into speech and language in the near term. The present investigation begins to address such transitional issues by looking at early gesture use and later language development in children with FXS who varied in their degree of autism symptoms. Specifically, we asked if increased use of communicative gestures in the prelinguistic period correlated with better language outcomes in children with high versus low degrees of autism symptoms.

Method

Participants

Participants were young children (21 boys, 4 girls) with FXS with limited expressive language living in the United States. Participants were chosen from a body of participants for a larger FXS study. Recruitment efforts for the larger study included advertising at national conventions, using a national research registry, networking with FXS family support groups, and advertising via an FXS parent list serve. On average, participants in the present study were approximately age 2;3 (years;months) during the first observation period (age range = 15–41 months) and were approximately age 4;11 during the second observation period (age range = 47–69 months). Although there was variability in the participants' chronological ages, they were selected for the present study because they all had similar limits in verbal abilities at the first observation. Participants for the present investigation were identified by reviewing data from previously coded observations. Participants were included if, according to their data records, they produced fewer than five different spoken or signed words during the 25 min of video-recorded parent–child observations. More information about the contexts and coding reliability is presented later in the Method section. Participants came from a variety of social, racial, and ethnic backgrounds. Seven of the children came from families classified as low-income based on U.S. Department of Health and Human Services guidelines of 200% of poverty and factoring in family size. Twenty-two of the children were White, 2 were African American, and 1 was Hispanic. Of the 25 participants, 22 were receiving speech and language and/or special education intervention at Time 1. On average, participants received 1.11 hr of speech services per week (range = 0–2.5 hr) and 0.98 hr of special education services per week (range = 0–12 hr).

Additional participant information is presented in Table 1, including mean composite scores for the Mullen Scales of Early Learning (MSEL; Mullen, 1995) and the Childhood Autism Rating Scale (CARS; Schopler, Reichler, & Renner, 1988). The MSEL is an assessment of early cognitive and motor development composed of five subscales: Gross Motor, Fine Motor, Visual Reception, Receptive Language, and Expressive Language. The MSEL composite score has an M of 100 and an SD of 15. Scores from the MSEL show that, on average, the participants were severely delayed compared with typically developing peers.

The CARS is a 15-item behavior rating scale that measures autistic behavior in young children. The scale includes the following items: relating to people; imitation; emotional response; body use; object use; adaptation to change; visual response; listening response; taste, smell, and touch response and use; fear or nervousness; verbal communication; nonverbal communication; activity level; level and consistency of intellectual response; and general impressions. Scores on the CARS may range from 15 to 60, with a score of 15 indicating that the child's behavior was rated within normal limits for all 15 items and a score of 60 indicating that the child's behavior was rated as severely abnormal on all 15 items. Scores above 30 are consistent with a diagnosis of autism.

Although formal autism diagnoses were not recorded for the various participants, the CARS was administered to all participants by research staff at both observation points. For the purpose of creating subgroups, we used an average of CARS scores from Time 1 and Time 2, with a score of 30 or above indicating placement in a high autism symptomatology subgroup. The average score was used because many of the children were younger than 2 years of age at Time 1, and we were concerned that scores from these younger children related more to overall developmental issues rather than autism symptoms. Two out of 4 female participants were placed in the high autism symptomatology subgroup, whereas 14 out of 21 male participants were placed in the high autism symptomatology subgroup.

Data Collection

In addition to data from the MSEL and CARS, information about children's communication use in parent–child interactions was obtained from videotaped recordings obtained at both observations. Within the same day of observation, five samples (each 5 min long) from a variety of parent–child activities (i.e., book reading, making and eating a snack, free play, and daily living activities such as picking up toys or making the bed) were collected by a research assistant who traveled to each child's home. These contexts were observed for each child at both observation times. Parents were read instructions prior to each context. For example, the instructions read prior to book reading were "We would like to see how you and (child's name) read or look at books together for 5 minutes. You can use one of your books that (child's name) likes, or you can use one or more of the books I've brought along. You can spend the entire 5 minutes reading one book, or read more than one book." Instructions read at the outset for the other four contexts are available from the second author. Samples were combined for analyses, yielding an analysis of 25 min of video per participant.

These activities were selected because they are common to parent–child interactions during early childhood and provide opportunities for different types of communication, such as requesting (orrejecting) snack items andreferring to pictures in books. Thus, our activities were designed to sample representative contexts, yet we do not know how representative their observed communication was compared with what occurred during everyday interactions that were not videotaped.

Behavioral Coding—Videotapes were later coded using Noldus Observer software (Version 5.1; Noldus Information Technology, 2002). Two child measures coded were rate of total communication and rate of number of different words observed during the 25 min of recorded interaction. Rate of total communication was obtained by counting the number of all communication acts coded and dividing this number by the total time in minutes. Communication acts included prelinguistic gestures and vocalizations as well as words, signs, or symbols that were clearly directed to the mother. Any words or signs were transcribed, and the number of different words or signs divided by the total time of observation for each participant was entered into our analyses.

Graduate students were trained to identify and code intentional communication acts to a training criterion of at least 80% agreement across three different samples before coding participant files from the present investigation. Once this criterion was met, two coders independently coded child communicative behaviors for each observation file. Following the independent coding, transcripts were compared, and any disagreements were resolved through consensus. This process was implemented to ensure consistency across coders and over time. To determine the interjudge reliability for each behavior coded, intraclass correlation coefficients (ICCs; using the consistency definition; Shrout & Fleiss, 1979) were calculated for each measure. ICCs were calculated between the primary and reliability codes and between the codes arrived at by consensus and the primary codes. This procedure was used to determine whether the consensus coding procedure biased the data. Consistency definition ICCs were high, ranging from .83 to .96. These strong correlations indicate that (a) differences in the final behavior codes derived from consensus coding and (b) those of primary coders had an extremely small effect on the relative performances of participants.

Gesture Type Coding—For observation period 1 only, all intentional communication acts that included a gesture were further described using gesture type coding. Gesture types included both deictic and representational gestures. Gestures coded included touching an adult for a specific communicative function (e.g., leading by the hand), pointing while

touching the object indicated, tapping an indicated object, pushing away an offered object, throwing an object with communicative intent, moving an object toward or away from an adult, showing an object to an adult, giving an object to an adult, pointing from a distance, reaching for an object, raising arms up to be picked up, pantomimes, waving, shrugging shoulders, making a "sshh" gesture, shaking/nodding head, expectantly displaying an upturned palm (as if stating, "Give it to me"), displaying two upturned palms (as if asking, "Where?"), signaling "come here" by wiggling one or more fingers of an upturned palm, clapping, covering the mouth as if surprised, crossing the arms to show resistance, and patting a chair (as if requesting "Sit by me"). Descriptions of the gesture types coded can be found in the Appendix. Gestures were coded as communicative only if they were accompanied by attention to the adult and showed joint reference. Attention to the adult was demonstrated in a number of ways, including intentionally touching the adult, looking at the adult, showing an object to the adult, giving an object to the adult, or moving an object toward the adult. In specific cases in which there was clear joint reference between the child and mother, such as shared book reading, attention to the adult was inferred.

As in the first phase of coding, the reliability coder was trained to a standard of at least 80% agreement with the primary coder across three practice files prior to actual coding. Twenty percent of all video recordings were coded separately by the primary and reliability coder to assess interrater reliability. The mean percentage agreement for gesture type coding was 94% with a range of 80% to 100%.

Observation 2—Observation period 2 communication variables included the following language outcome measures: (a) rate of number of different words (said or signed) used and (b) total rate of communication (including words, gestures, communicative vocalizations, signs, or other forms of augmentative and alternative communication) observed per minute. These data were obtained from examining the previously described 25 min of videotaped parent–child interaction from Time 2, counting the number of different words or other communication forms, and dividing these numbers by the total amount of time in minutes. Rate measures were used to account for slight variations in the total amount of time in each video-recorded communication sample. Interrater reliability for these measures was also high: ICC for number of different words = .99, ICC for total rate of communication = .97.

Results

Descriptive information and data pertaining to children's initial developmental status are presented in Table 1. As indicated by the data in this table, a great deal of variability in test scores was observed across participants, despite the fact that all participants were essentially nonverbal communicators at the initial observation. Scores from the MSEL and CARS indicated a range of developmental attainments and autism symptoms.

Our first step of analysis was to look for relationships between the variables listed in Table 1. Pearson correlations that were completed between scores from the MSEL and the CARS indicated that these scores were significantly correlated to each other ($r = -.581$; $p = .002$). As expected, children with higher scores on the CARS had lower scores on the MSEL.

The next set of analyses explored relationships between Time 1 gesture use and two language outcome variables from Time 2, total rate of communication and rate of number of different words used by children. We decided to use number of different gestures at the first observation (as opposed to rate of gesture use) as our index of gesture use for two reasons. First, studies have found that the variety of gestures produced was positively related to language outcomes (e.g., Rowe et al., 2008). Second, one outcome of interest was the rate of

total communication, including gestures, at the second observation, and we assumed that rate of gesture use at Time 1 would significantly relate to the overall rate.

We conducted correlation analyses between number of different gestures and language outcome measures for the entire sample of 25 participants. In addition, because the degree of autism symptomatology is a variable of considerable interest to researchers and interventionists working in the area of FXS, we decided to further explore language outcomes within subgroups of children with high versus low scores on the CARS. As described in earlier sections of this article, scores from the CARS can range from 15 to 60, with scores above 30 considered to be consistent with an autism diagnosis. The subgroups for our analyses consisted of children with scores below 30 (low autism symptomatology, n = 9) and a subgroup of children scoring 30 and above (high autism symptomatology, n = 16). The Ms and SDs for the variables of interest for the entire group and within each subgroup are presented in Table 2. The difference in mean number of different types of gestures produced by the low versus high autism symptomatology groups was not significant.

For the entire group of 25 participants, correlations between initial gesture use and Time 2 language outcomes were not significant ($r = -.213$ for rate of total communication; $r = -.119$ for rate of number of different words). However, when we considered the correlations between these variables within the subgroups of children with low versus high scores on the CARS, significant differences emerged. For children with high scores on the CARS, the number of different gestures was significantly—negatively—correlated to the rate of number of different words observed at the second observation ($r = -.532$; $p = .034$). The correlation between number of different gestures and rate of total communication was also negative ($r = -.449$), but this was not significant at the .05 level ($p = .081$). Correlations within the low CARS group were not significant ($r = .255$ for rate of total communication, and $r = .033$ for rate of number of different words).

Participants communicated primarily with gestures (as opposed to nonword vocalizations) at Time 1, with an average of 65% of their communication consisting of gestures. We looked further at the type of gestures produced by the children at the first observation only. Although we noted great variability across participants in both groups, the most frequently observed types of gestures were touching adults, giving objects, pushing away objects, tapping objects, and moving objects toward the communication partner. Noteworthy differences between groups, however, were observed in the use of contact points and gives. Almost half of the participants with low CARS scores used a contact point at least once during the first observation, but less than 10% of participants in the high CARS group used a contact point during the first observation. Conversely, over half of the participants in the high CARS group were observed to give an object to a communication partner, whereas only one third of participants in the low CARS group were observed to use a give gesture.

The majority of the children were receiving speech and language and/or special education interventions, so we also looked at whether differences in hours of intervention provided to each child might relate to differences in our language variables. No significant relationship between number of hours of intervention and language outcomes was detected. Two other variables that have been considered in past research— canonical vocalizations at Time 1 and gender—were also considered as potential factors influencing communication outcomes at Time 2; however, no significant relationships were found. In addition, it should be noted that female participants were distributed equally between the high and low CARS groups.

Discussion

The findings presented in this study should be considered preliminary because a relatively small sample was included, and the analyses were only correlational. Thus, we cannot infer any causal relationships between gesture use and later language. However, it was surprising that, unlike past studies finding that children who used more prelinguistic gesture types had better communication outcomes (Rowe et al., 2008), some children in our study showed the opposite effect. Specifically, children with FXS and high autism symptomatology who used more gesture types in the preverbal stage of communication had lower vocabulary diversity about 2 years later. We will focus on possible explanations for these findings in the remainder of the discussion.

Our study examined the relationship between gesture types and later expressive language use in natural communication situations. Past studies (e.g., Rowe & Goldin-Meadow, 2009; Rowe et al., 2008) used receptive vocabulary measures to examine communication outcomes. The different outcome measures examined across studies may be partially responsible for the difference in findings. That is, it may be that gesture use is more closely related to receptive as opposed to expressive language development, at least during the developmental phases examined in the present study. The relationship between gesture and spoken versus comprehended language appears to change over time in typically developing children and children who are late talkers (Bates & Dick, 2002) and is likely to also differ according to development in children with intellectual disabilities.

The context of observation is another variable likely to influence results across studies. In the present study, gestures were measured during unscripted, naturalistic mother–child interactions. Other research protocols have provided specific contexts designed to evoke use of specific gestures (e.g., Liszkowski, Albrect, Carpenter, & Tomasello, 2008) or relied on parent report of gesture development (e.g., Roberts et al., 2002). Our procedures may not have sampled sufficient time or number of contexts to adequately represent different types of gestures that could be produced by children under specific circumstances. Bates and Dick (2002) summarized results from several studies and concluded that the degree of correlation between gesture use and word production depends largely upon the degree of contextual support offered during assessment of gesture use.

Differing findings may also be due to the types of gestures recorded. The majority of gestures recorded in the present study were contact gestures, such as giving, pushing away, and touching an adult. Contact gestures typically precede distal or representational gestures. The fact that our sample of children with FXS and high scores on the CARS produced mostly contact gestures suggests that they had not moved on into more advanced gestural communication. Much of the research relating early gesture use tolater language development looked specifically at more sophisticated forms of gesture, such as distal pointing (Brooks & Meltzoff, 2008; Butterworth & Morisette, 1996; Tomasello, Carpenter, & Liszkowski, 2007) and representational gestures (Goodwyn & Acredolo, 1993). The present results suggest that producing a variety of types of gestures that do not include these more advanced, social types of gestures is not useful for predicting later language outcomes.

In the present study, the use of contact gestures (in which the communicator makes direct contact with the refererent or partner; cf. McLean, McLean, Brady, & Etter, 1991) was especially predominant in the subgroup of children with high CARS scores. This may explain the negative correlation between number of different gestures and communication outcomes for this subgroup. Using a variety of contact-type gestures does not appear to relate to positive language out-comes in this particular group.

Differences in the methodologies used in this study and past studies, however, limit conclusions regarding specificity of findings to children with fragile X, with or without high autism symptomatology. That is, we cannot conclude that the negative correlations are related to having a diagnosis of fragile X and a high number of autism symptoms. Replications with larger numbers of participants and with participants who have other known causes of developmental disability are needed before such a conclusion could be drawn. In addition, analyses that include measures of language comprehension and that examine communication across different experimental contexts are needed. Such analyses would facilitate interpretation of the present results with other research on gesture and early language development.

Although these results are based on correlations with a relatively small sample, they could have important implications for intervention. Specifically, prelinguistic interventions may have greater impact on later language if they focus on specific types of prelinguistic communication, such as pointing and other social gestures, rather than contact gestures or increasing gesture use in general. Examples of potentially beneficial types of gestures include teaching a child to show or point to interesting or novel objects and events; using gestures to represent different social games and interactions, (e.g., eensie weensie spider); using conventional gestures such as a shoulder shrug; and producing a "sshh" gesture to quiet a stuffed animal in a game. The present study, along with past research, suggests that these types of gestures may be more specifically beneficial for word production than gestures that communicate more regulatory functions such as reaching to request.

In conclusion, although the present findings suggest important relationships between early gesture types and language development, much research is yet to be done. As mentioned previously, the extent to which our findings extend to other children with developmental disabilities cannot be determined. Future research that replicates and extends these findings with other populations and across other sampling contexts, and across multiple developmental stages, is needed. Intervention studies that examine the effectiveness of specific gesture-teaching protocols are also needed, particularly for children who have relatively high autism symptomatology and fragile X syndrome.

Acknowledgments

Appendix

Appendix:

Gesture type descriptions

Type of gesture	Gesture description
Distal point	The index finger is extended toward the object/person of interest and is 6 in. or more from the object. Other fingers are curled under.
Touching the adult	Touching an adult with clear communicative intent.
Showing an object	Child extends the object toward the adult with the sole intention of showing the object.
Giving an object	Child gives an object to adult. Child must release the object, and the adult must accept the object.

Type of gesture	Gesture description
Tapping	Child taps the object while sharing attention with the adult. Tapping may be with whole hand or with a finger.
Contact point	Child touches an object with the index finger. *At least two of the adjacent fingers should be curled under or arched up.*
Abbreviated reach	Child reaches for an object but does not directly grab it. There should be a *momentary, expectant pause by the child.*
Moving object away	The child *distinctly and purposefully* moves the object away from the adult.
Pantomime	Pantomime is the use of a part of the body or face to imitate an object or the use of an object.
Raising arms up	Child raises his or her arms up to indicate that he or she would like to be picked up.
Moving object toward	The child *distinctly and purposefully* moves an object toward the adult.
Throwing/dropping	This act must have meaning in order to be coded as a gesture. Back-and-forth ball games should not be coded as gestures.
Waving	Child waves the hand or arm; can be directed toward an object or a person (for the purpose of greeting or saying good-bye).
Shrugging shoulders	A shrug includes lifting of the shoulders to the ears or upturning of palms to indicate "What" or "I don't know."
Upturned palm	The palm should be upturned as if to say "Give that to me."
Both palms upturned	Both hands are held palms up and to the side as if to say/ask "Where is ___?"
Come here	Upturned palm with one or more fingers or the whole hand wiggling to convey the message to come.
Sshh	The gesture must be distinctive, with the finger held in close approximation to the mouth.
Head nod/shake	A head nod or shake must be intended to convey the message "yes" or "no."
Crossed arms	Child crosses arms over chest to show dissatisfaction—not just a resting stance.
Clapping	Child brings hands together quickly in midline; palms usually touch.
Hands over mouth	Child places one or both hands over mouth, as if to express surprise.
Patting chair	Child pats chair, as in "Sit by me."
Pushing object away	The purpose of this gesture is always rejection or a signal that the child is finished with the object.
Not otherwise specifie	Gestures that are not on the list but appear to be clearly communicative.

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Table 1

Summary of participants′ages and standardized test scores.

Variable	*M*	*SD*	Range
Chronological age in months	27.00	7.14	15–40
MSEL Composite	50.96	3.32	49–63
CARS	30.2	4.76	21.25–37.25

Note. Chronological age and Mullen Scale of Early Learning (MSEL) scores are from Time 1. Childhood Autism Rating Scale (CARS) scores are the average between Time 1 and Time 2.

Table 2

Gesture types at time 1 and language outcome measures at time 2.

Group	Time 1		Time 2					
	Gesture types		Rate of total communication acts		Rate of number of different words			
	M	*SD*	*M*	*SD*	*M*	*SD*		
Total sample (n = 25)	3.96	2.06	4.18	2.80	2.35	2.57		
Scores 30 on CARS (*n* = 16)	3.69	2.03	3.37	2.38	1.48	1.98		
Scores 30 on CARS (*n* = 9)	4.60	1.78	5.36	2.98	3.49	2.89		

Note. Reported rates are per minute.