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Assessing Gestures in Young Children with Autism Spectrum Disorders

Allison Bean Ellawadi and Susan Ellis Weismer

Abstract

Purpose—To determine whether scoring of the gestures *point*, *give*, and *show* were correlated across measurement tools used to assess gesture production in children with an Autism Spectrum Disorder (ASD).

Method—Seventy-eight children with an ASD between the ages of 23 to 37 months participated. Correlational analyses were conducted to determine whether performance of three key gestures related to joint attention and behavior regulation (*point*, *give*, *show*) were correlated across three different measurement tools: the *Autism Diagnostic Observation Schedule*, the *Early Social Communication Scale*, and the *MacArthur-Bates Communicative Developmental Inventory: Words and Gestures*. To establish whether different measures were related at different points in development, children were subdivided into two groups based on their expressive language levels.

Results—The scoring of gesture performance was not entirely consistent across assessment methods. The score that a child received appeared to be influenced by theoretical perspective, gesture definition, and assessment methodology, as well as developmental level.

Conclusion—When assessing the gestures of children with ASD clinicians should determine what aspects of gesture they are interested in profiling, gather data from multiple sources, and consider performance in light of the measurement tool.

Keywords

Assessment; autism; language; gestures

Introduction

Gestures are strong predictors of concurrent and future language skills in many populations including children who are typical language learners (e.g., Iverson & Goldin-Meadow, 2005; Rowe, Ozcaliskan, & Goldin-Meadow, 2008), late talking toddlers (Thal & Tobias, 1992), and children with an Autism Spectrum Disorder (ASD) diagnosis (e.g., Charman, Drew, Baird, & Baird, 2003; Luyster, Kadlec, Carter, & Tager-Flusberg, 2008). Gesture and language are tightly linked developmentally; children refer to objects using gesture prior to producing labels verbally and produce supplementary gesture-speech combinations prior to the onset of multi-word phrases (Iverson & Goldin-Meadow, 2005; Ozcaliskan & Goldin-

Meadow, 2005). Gestures also serve an important pragmatic function. They enable preverbal children to communicate intentionally. Children use gestures to initiate episodes of joint attention (e.g., pointing to an interesting object or event for the purpose of sharing that experience with their communication partner), regulate the behavior of their communication partner (e.g., pointing to request a desired object), and engage in social interactions (Bruner, 1981). Because gestures provide important information about a child's current social-communication skills and potential for communication growth, researchers have emphasized the importance of incorporating gesture profiling into communication skills assessment (Capone & McGregor, 2004; Crais, Watson, & Baranek, 2009). This need is further supported by the integration of gestures and verbal communication as part of the criteria for ASD under the *Diagnostic and Statistical Manual –Fifth Edition* (DSM-5) (American Psychiatric Association, 2013).

When profiling the gestures of children with ASD, joint attention gestures may be especially important given that joint attention is hypothesized to be a “pivotal skill” for this population (Charman, 2003). Joint attention is a strong predictor of concurrent and later language skills (e.g., Dawson et al., 2004; Luyster et al., 2008). Three such gestures, *point*, *give*, and *show*, emerge early in typical development (between 9 to 15 months of age) (e.g., Carpenter, Nagell, & Tomasello, 1998) and may be used to initiate episodes of joint attention, regulate the behaviors of others, and engage in social interactions. Differentiating between gesture function may be particularly important for children with ASD given that they demonstrate a different pattern of production than that observed in typical language learners. Typical language learners produce a higher proportion of joint attention than behavior regulation gestures, whereas individuals with ASD show the opposite pattern (Maljaars et al., 2011; Shumway & Wetherby, 2009; Stone et al., 1997).

Multiple measurement tools are available to assess production of *point*, *give*, and *show* including the *Autism Diagnostic Observation Schedule* (ADOS; Lord, Rutter, DiLavore, & Risi, 2002), the *Early Social Communication Scale* (ESCS; Mundy, Hogan, & Doehring, 1996), and the *MacArthur-Bates Communicative Development Inventory: Words and Gestures* (CDI-WG; Fenson, Marchman, Thal, Dale, Reznick, & Bates, 2007). These measurement tools have been used in research studies to profile the gestures of children with ASD (e.g., Charman et al., 2003; Ellis Weismer, Lord, & Esler, 2010; Lawton & Kasari, 2012; Wong & Kwan, 2010). However, they differ in fundamental ways including theoretical framework and focus, which influence how the gestures are defined and subsequently scored. Additional variations exist across these tools with regards to assessment methodology. It is possible that children may receive different scores across measurement tools as a consequence of these differences.

The ADOS was designed to elicit behaviors identified as important to the diagnosis of ASD including the use of gesture as part of a social interaction in children with no receptive or expressive language to verbally fluent adults (it is not appropriate for nonverbal adolescents or adults). Each of the four modules is designed for use with individuals at specific developmental levels (Lord et al., 2002), from toddlers to adults. The ADOS is a well-accepted and widely used autism diagnostic measure with good reliability and validity (e.g., Chawarska, Klin, Paul, & Volkmar, 2007; Ellis Weismer, et al., 2010). The tasks used

during the assessment are designed to provide standard contexts in which behaviors of interest can be observed. For example, offering the child a snack provides an opportunity for the child to make a request (Lord et al., 2002).

The ESCS is a structured observation designed to measure nonverbal social skills that typically emerge in children between 8 to 30 months of age and has been identified as a reliable and valid index of these early social-communication skills (e.g., Kasari, et al., 2006; Mundy et al., 1986). Rather than focusing on behaviors representative of ASD, the ESCS was designed to assess social-communicative development in children with typical language development and children with developmental delays. Because the ESCS is directly based on Bruner's (1981) theoretical framework, scoring takes into account the complexity and communicative function (joint attention, behavior regulation, social interaction) of the child's nonverbal behaviors (Mundy et al., 1996). A variety of tasks are used throughout the assessment, such as presenting a wind-up toy to elicit specific gestures (e.g., *pointing* to initiate an episode of joint attention).

The CDI-WG is a parent checklist that provides a measure of the early language skills of children between the ages of 8 to 18 months, including their gesture repertoire. The Early Gestures section probes children's use of gesture for intentional communication and social interactions and the Later Gestures section probes emerging symbolic understanding and includes some aspects of play (Fenson et al., 2007). Although the CDI-WG was designed for children under the age of 18 months, it has been widely used to assess children with ASD who fall outside of the specified age range and has excellent reliability and validity for children with typical language development and children with an ASD (Charman et al., 2003; Fenson et al., 2007; Luyster et al., 2008).

Although all three measurement tools assess *point*, *give* and *show*, they differ in fundamental ways. *Pointing* may be used to regulate the behaviors of others or initiate episodes of joint attention. The ADOS collapses behavior regulation and joint attention *pointing* into one broad *point* category. Due to the focus on quality, scorers consider the presence or absence of coordinated eye contact, the number of contexts in which the child points, and the distance of the referent (proximal vs. distal). In addition to one broad *point* category, joint attention (which may be established with or without a *pointing* gesture) and requesting (which may occur through "gesture, vocalization, facial expression or other means") are scored as separate variables in the assessment (Lord et al., 2002). In contrast, the ESCS focuses on the function (behavior regulation, social interaction, joint attention), as well as the frequency, of the gesture. *Pointing* may be categorized as serving either a joint attention or behavior regulation function and is scored regardless of whether or not it occurs with eye contact (coders do make note when the gesture does occur with eye contact) (Mundy et al., 1996). Because the ESCS does not require eye contact, *pointing* gestures may be scored in instances where it is unclear whether the child is using the point to request an object. The CDI-WG focuses on whether a gesture is absent, emerging, or present in the child's gesture repertoire. *Pointing* is defined as a point (with arm and index finger extended) at some interesting object or event. Parents indicate which descriptor (not yet-sometimes-often) characterizes their child's current abilities (Fenson et al., 2007). While the definition of *pointing* on the CDI-WG is phrased to limit reporting to *pointing* gestures used to establish

an episode of joint attention, it may be difficult for a parent to differentiate between *pointing* gestures for behavior regulation and *pointing* for joint attention. That is, a parent may think that a child is showing interest in a toy and requesting the toy using the same *pointing* gesture. The CDI-WG assesses requesting by asking parents to indicate whether or not their child “requests something by extending arm and opening and closing hand”.

Differences are also apparent in how *giving* and *showing* are defined across the measurement tools. On the ADOS, *giving* is defined as the spontaneous release of an object for the purpose of sharing, getting help, or as part of a routine. During the balloon task the child may *give* the balloon to the examiner for the purpose of continuing the routine of the examiner blowing up the balloon and letting it go. In this example, *giving* is used to regulate the examiner’s behavior. For a child to receive the highest score, he or she must *give* an object to another person for the purpose of sharing, such as *giving* the examiner a cracker during the snack portion of the assessment. Therefore, scoring takes into account the function of the gesture (a child must give an object to another person for the purpose of sharing at least once to achieve the best score) as well as the number of contexts in which the child produces the gesture. On the ESCS, *giving* is categorized as a requesting behavior in which the child pushes or holds an object towards the examiner to get help. Tasks such as placing interesting objects in clear plastic jars that the child is incapable of opening are used to elicit *giving* gestures. *Giving* on the CDI-WG is defined as reaching out and *giving* a toy or some object that he/she is holding.

On the ADOS *showing* is defined as deliberately orienting or placing an object where it can be seen by another person, such as holding up a toy truck to *show* the parent or examiner. This does not include instances where the child orients the object for the purpose of getting help or participating in a routine (e.g., *showing* the jack-in-the-box for the purpose of getting help). Scoring takes into account the frequency and the quality of the gesture (e.g., coordinating the gesture with eye contact) (Lord et al., 2002). *Showing* on the ESCS is categorized as a joint attention behavior, in which the child raises a toy upward, towards the examiner’s face. Behaviors such as holding up the toy glasses for the examiner to see would be categorized as *showing* (Mundy et al., 1996). On the CDI-WG *showing* is defined as the child extending an arm to show you something that he/she is holding (Fenson et al., 2007).

In addition to the aforementioned differences, these measurement tools also vary in administration. The ADOS and ESCS are administered by examiners and use tasks designed to elicit behaviors of interest. Although this increases the probability of a child producing the behavior of interest, this does not guarantee that a behavior will be produced over the course of an observation (Carpenter et al., 1998). Children may be less likely to produce behaviors of interest for an unfamiliar adult. Examiner familiarity has been found to influence test performance in preschoolers with language impairment and school-age children with disabilities (Fuchs, Featherstone, Garwick, & Fuchs, 1984; Fuchs, Fuchs, Power, & Dailey, 1985). Crais, Douglas and Campbell (2004) attribute the earlier documentation of *giving* and *showing* gestures in their sample to methodological differences including their use of the parent, rather than an examiner, as the elicitor. In contrast to the ADOS and ESCS, the CDI-WG relies on parent report. Researchers have found a high level of congruence between parent report and observation and/or elicitation when they examined

gesture development in young typically-developing children (Bates, Bretherton, & Snyder, 1988; Crais et al., 2004).

In summary, gesture production is correlated with current and later language skills in children with ASD. As such, it is important to assess gesture production in this population when profiling their social-communication skills and as part of the inclusion criteria for ASD under the DSM-5 (American Psychiatric Association, 2013). Three widely used measurement tools vary in how three key gestures, *point*, *give*, and *show*, are defined and subsequently scored, and assessment methodology. Given the importance of gesture profiling and the noted variations across measurement tools, we sought to determine whether scoring of the gestures *point*, *give*, and *show* was correlated across the ADOS, ESCS, and CDI-WG.

Methods

Participants

Participants included 78 children with ASD (70 male, 8 female) without phrasal speech. The children had a mean chronological age of 30 months (SD = 3.8 months, range = 23–37 months). Table 1 provides demographic information, as well as information regarding autism severity, cognition, and language abilities for this sample of participants. The participants were part of a larger longitudinal study examining early language development in young children with ASD. Children who were diagnosed or suspected to be on the autism spectrum were recruited from a variety of sources including pediatricians, a statewide early intervention program for infants and toddlers exhibiting developmental delays, and a university-based developmental disabilities clinic.

Instruments

The ADOS is a semi-structured, standardized assessment of social interaction skills and behaviors that is designed to establish a diagnosis of autism or autism spectrum. All participants received either the Toddler version (n=47) or Module 1 (n=38) of the ADOS (scoring for the gestures *point*, *give*, and *show* is equivalent across these modules). Administration occurs in a room that contains an appropriate size table. The child may choose to complete the activities at the table or while standing or sitting on the floor. The child is encouraged to move around the room throughout the assessment (Lord et al., 2002). The ESCS is a structured observation designed to provide measures of nonverbal communication skills that typically emerge in children between 8 to 30 months of age. The child is seated at a table throughout the evaluation while the examiner presents a variety of objects and tasks that are intended to elicit social and communicative bids with the examiner (Mundy et al., 1996). The CDI-WG is a parent checklist that assesses verbal and nonverbal communication as well as some aspects of play. In the Words and Gestures section of the questionnaire parents are asked to indicate whether their child uses a specific gesture *often*, *sometimes*, or *not yet* (Fenson et al., 2007).

Procedure

The university Institutional Review Board approved the study protocol and written parental consent was obtained for each participant prior to testing. A comprehensive diagnostic evaluation was performed for each child upon entry into the study. The evaluation included a toddler research version of the Autism Diagnostic Interview-Revised (ADI-R; Rutter, Le Couteur, & Lord, 2003) and Autism Diagnostic Observation Schedule (ADOS) or Autism Diagnostic Observation Schedule-Toddler Module (ADOS-T; Luyster et al. 2009). Cognitive and adaptive behavior testing included the Cognitive Scale of the Bayley Scales of Infant and Toddler Development-Third Edition (Bayley-III; Bayley, 2006) and the Vineland Adaptive Behavior Scales-Second Edition, Survey Interview Form (Vineland-II; Sparrow, Cicchetti, & Balla, 2005). Using all available information and assessment results, best estimate clinical diagnoses were made using DSM-4 or ICD-10 criteria. Best estimate diagnoses, which are commonly used (e.g., Chawarska et al., 2007; Lord et al. 2006), have been shown to be reliable (Klin, Lang, Cicchetti, & Volkmar, 2000) and generally stable over time, even for children who receive their diagnosis prior to the age of 3 years (Moore & Goodson, 2003; Stone et al., 1999). In addition, children were given the ESCS. Parents completed the CDI-WG just prior to the first session.

Children were seen for two sessions by examiners who had experience assessing children with ASD. One session included administration of the ADOS along with cognitive testing by a trained psychologist. The other session included administration of the ESCS by an experienced licensed speech-language pathologist. During this session, children also participated in other speech and language testing in addition to some experimental tasks. Each session lasted approximately 2 to 3 hours. While most sessions were scheduled on different days, some children were seen for back-to-back sessions, with the time taken for lunch used to break up the sessions. Because the psychologist administered the ADOS and the speech-language pathologist administered the ESCS, this ensured that the examiner was unfamiliar for both assessments.

The gestures *point*, *give*, and *show* were scored on each of the measures. In this study we were interested in whether performance was correlated across measures that differed with respect to gesture definition and assessment methodology. Frequency, which was considered within each of the tests' scoring guidelines, was used to equate scoring. We converted this information to an ordinal scale to equate scoring across assessment measures and enable the calculation of correlations. Children received a score of 3 on the ADOS and ESCS if they produced the targeted gesture more than once, a score of 2 if the gesture was produced once, and a score of 1 if the gesture was never observed. Ratings on the CDI-WG were transformed according to the same guidelines. Children received a score of 3 if the gesture was reported to occur *often*, a score of 2 if the gesture was reported to occur *sometimes*, and a score of 1 if the parent reported that the child did *not yet* produce the gesture.

Results

The number of children who produced each gesture is summarized in Table 2. Spearman rank correlations were calculated for each gesture for the entire sample (ASD). On the ESCS two *pointing* gesture scores are reported because the measurement tool scores distinguish

between joint attention (JA) *pointing* and behavior regulation (BR) *pointing*. There were significant correlations between *pointing* on the ESCS - BR and ADOS ($r=.43$), the ADOS and CDI-WG ($r=.47$), and the ESCS-JA and ESCS-BR ($r=.30$) with medium effect sizes ($ps<.01$; Cicchetti et al., 2010). The significant correlations between the ESCS - JA and ADOS ($r=.22$), the ESCS-JA and CDI-WG ($r=.25$), and the ESCS-BR and CDI-WG ($r=.23$) had small effect sizes ($ps<.05$). The correlation between *showing* on the ESCS and ADOS ($r=.32$, $p<.01$) also had a medium effect size. There was not a significant correlation between *showing* on the CDI-WG and ADOS ($r=.06$) or the CDI-WG and ESCS ($r=-.09$). The correlation between *giving* on the ESCS and the CDI-WG ($r=.24$, $p<.05$) had a small effect size. There was not a significant correlation between *giving* on the ADOS and the ESCS ($r=.11$) or the ADOS and the CDI-WG ($r=.22$).

Subgroup Analysis

In order to determine whether these findings held at different levels of development, children were divided into two subgroups based on the number of words reported in their expressive vocabulary on the CDI-WG. By 9 to 15 months of age children begin to produce the gestures *point*, *give*, *show* (e.g., Carpenter et al., 1998) and by the age of 16 months most children have an expressive vocabulary of at least 20 words (Fenson et al., 2007). Given the relationship between gesture and vocabulary, children with an expressive vocabulary greater than 20 words were placed in the ASD- Large vocabulary group (ASD-L) and children with an expressive vocabulary containing less than 20 words were placed in the ASD-Small vocabulary group (ASD-S). Twenty-nine of the children had more than 20 words in their expressive vocabulary. Forty-nine children had less than 20 words in their expressive vocabulary. Spearman rank correlations were calculated for each gesture for each group. For the ASD-L group, there were no significant correlations for *pointing*. The correlation between *showing* on the ESCS and ADOS ($r=.53$, $p<.01$) had a medium effect size. The correlation between *showing* on the CDI-WG and ADOS ($r=-.17$) and the ESCS and CDI-WG ($r=-.22$) were not significant. There were no significant correlations for *giving*.

For the ASD-S group, JA *pointing* on the ESCS was not included in the analysis because no children produced JA *points* on the ESCS. There were significant correlations between *pointing* on the ADOS and ESCS-BR ($r=.43$, $p<.01$), the ADOS and CDI-WG ($r=.47$, $p<.01$), and the ESCS-BR and CDI- WG ($r=.33$, $p<.05$) with medium effect sizes. There were no significant correlations for *showing*. The correlation between *giving* on the CDI-WG and ADOS ($r=.33$, $p<.05$) had a medium effect size. There was not a significant correlation between *giving* on the ESCS and CDI-WG ($r=.13$) or the ESCS and ADOS ($r=.05$).

Results Summary

In summary, no measure was significantly correlated with the other measures across all three gestures. For the entire sample, the ESCS and ADOS were correlated for two of the three gestures (*point*, *show*). For the ASD-L subgroup, the ADOS and ESCS were correlated for one of the three gestures (*show*). For the ASD-S subgroup, the CDI-WG and ADOS were correlated for two of the three gestures (*point*, *give*).

Discussion

In this study we investigated whether scoring of the gestures *point*, *give*, and *show*, which may be used to initiate episodes of joint attention and regulate the behaviors of others, were correlated across the ADOS, ESCS, and CDI-WG. We hypothesized that variations in theoretical orientation, definition, and assessment methodology may yield differences in scoring across measurement tools. Results revealed that no one measure correlated with any of the other measures across all three gestures. In addition, differences were noted in these measures across vocabulary subgroups. Each gesture is considered in turn, in light of variations in definition and assessment methodology.

Pointing was the gesture with the most notable differences in definition across measurement tools. *Pointing* was correlated across three measures (ADOS, CDI-WG, and ESCS-BR) for the sample as a whole and the ASD-S subgroup. For this subgroup, over 50% of the children did not *point* on any of the measures and approximately 30% demonstrated *pointing* as an emerging behavior on the ADOS and CDI-WG. None of the children produced joint attention *pointing* on the ESCS, suggesting that the *pointing* gestures scored on the ADOS were used to regulate behavior and that on the CDI-WG parents reported behavior regulation rather than joint attention *pointing*. In contrast, *pointing* was not correlated across any of the measures for the ASD-L subgroup. We hypothesize that as children become more adept at using *pointing* gestures, like the ASD-L subgroup, variations in theoretical orientation and definition may yield different scores across measurement tools. The ESCS differentiated types of pointing, whereas the ADOS collapsed across functions and CDI-WG was designed to probe joint attention *pointing*. Seven percent of the children in the ASD-L subgroup produced more than one *pointing* gesture on the ADOS which requires coordinated eye contact, as compared to 34% of children who produced behavior regulation *pointing* on the ESCS (which does not require eye contact) and 24% who were reported to *point* consistently on the CDI-WG. Thus, grouping *point* gestures and subsequently defining them in different ways, appears to yield inconsistent scoring across measurement tools.

Giving was correlated for the CDI-WG and the ESCS for the sample as a whole, with the highest proportion of children (78%) producing more than one *giving* gesture during the ESCS as compared to the ADOS (23%) and CDI (40%). For the ASD-S subgroup, *giving* was correlated for the ADOS and CDI-WG. Although the medium correlation ($r=.32$) between *giving* on the ESCS and CDI-WG was not statistically significant for the ASD-L subgroup, this may reflect the small sample size. We hypothesize that the high number of *giving* gestures produced by the ASD-S subgroup on the ESCS was due to variations in assessment methodology. Forty-one percent of the tasks on the ESCS are designed to elicit *giving* (e.g. getting an interesting object out of a clear jar). Because children are seated at a table throughout administration, they are not able to move about the room, which may also increase the likelihood of eliciting multiple *giving* gestures. In contrast, children are encouraged to move about the room throughout the ADOS. Enabling children to move to another task if they become bored may decrease the likelihood of observing multiple *giving* gestures.

Showing, which had the most consistent definition across measurement tools, was correlated across the ADOS and ESCS for the entire sample and the ASD-L subgroup. However, it was not correlated across any of the measures for the ASD-S subgroup. Social impairments are a defining characteristic of ASD under the DSM-4 and DSM-5 (American Psychological Association, 1994, 2013). Previous research indicates that joint attention accounts for the smallest proportion of communication in children with ASD (Maljaars et al., 2011; Shumway & Wetherby, 2009). As such, we hypothesize that *showing* is less likely to be observed during a single time point. Seventy-eight percent of parents in the ASD-S subgroup reported that their child *sometimes* or *often* showed objects on the CDI-WG, as compared to 32% of children who produced at least one *showing* gesture on the ADOS and 2% who produced at least one *showing* gesture on the ESCS. Although the ESCS elicited a higher proportion of *giving* gestures for this subgroup, the assessment methodology does not appear to elicit *showing* gestures as well. During the ESCS, the examiner introduces objects by bringing them out onto the table where the child is seated. In contrast, during the ADOS children are mobile and have the opportunity to independently discover interesting objects in the room. Like the ADOS, on the CDI a parent may report on instances in which the child discovers interesting objects or events. Thus, children may be more likely to *show* objects during the ADOS and CDI given that the child may assume that the adult has not yet seen the object. These findings are also consistent with previous work indicating that examiner familiarity may influence children's gesture production (Crais et al., 2004). As such, children with ASD may be less likely to produce a *showing* gesture during a given evaluation with an unfamiliar examiner. In the ASD-L subgroup, 17% of the children produced at least one *showing* gesture on the ESCS as compared to 70% on the ADOS and 90% on the CDI-WG. Consistent with the ASD-S subgroup, parent report yielded the highest proportion of showing across the ASD-L subgroup. However, the large number of children who demonstrated showing on the ADOS in this subgroup suggests that as children become more adept verbal communicators, the likelihood of observing *showing* gestures during a single observation increases.

The finding that children were less likely to produce joint attention than behavior regulation gestures is consistent with previous research (e.g., Maljaars et al., 2011; Shumway & Wetherby; Stone et al., 1997). For the sample as a whole 91% of the children produced at least one *giving* gesture on the ADOS. In contrast, less than half of the children produced at least one *showing* gesture on the ADOS. The same pattern was observed on the ESCS, with 86% producing at least one *giving* gesture as compared to 7% who produced at least one *showing* gesture. With regards to *pointing* on the ESCS, 24% of the children produced a *pointing* gesture for behavior regulation as compared to 12% who produced a *pointing* gesture for joint attention. On the CDI, 91% of parents reported that their children produced *giving* gestures sometimes or often as compared to 80% who reported that their children produced *showing* gesture sometimes or often. This pattern held across the vocabulary subgroups.

Overall, these findings suggest that gesture performance may be influenced by a variety of factors. However, there are limitations to this study. Limitations include the use of gross measures to equate scores across measurements and limiting the analysis to three gestures.

An additional limitation was the small sample sizes, which decreased our statistical power, as well as the limited diversity of the families who participated in the study. Future work should continue to address gesture use across different assessment tools including further investigation into how intentionality is taken into consideration during scoring as well as comparison of different gesture types to determine whether deficits in gesture use are specific to joint attention or also include those used for behavior regulation.

Conclusion

Each of these measurement tools provides important insight into the gesture profiles of young children with ASD. The results from this study indicate that gesture profiles are likely to differ across measurements tool. When profiling gestures in children with ASD, it is critical for clinicians to determine what aspect of a gesture they are interested in profiling. For example, the ESCS may be best for assessing *giving* gestures and for assessing function given that it provides a clear distinction between joint attention and behavior regulation gestures. The ADOS may be most appropriate for clinicians interested in production of *pointing* gestures that are coordinated with eye contact. The CDI also provides important information regarding gesture development because parents have multiple opportunities across different contexts to observe their child's behaviors rather than the single time point that examiners have for observation. Parent report may be especially insightful for gestures that children with ASD are less likely to produce (e.g., *showing*). In conclusion, when profiling the gestures of children with ASD it is critical to consider performance in light of the instrument being used.

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Table 1

Participant characteristics and demographic information.

	ASD Total Sample N=78 n (%)	ASD-L Subgroup n=29 n (%)	ASD-S Subgroup n=49 n (%)
Gender			
Male	70 (90)	26 (90)	44 (90)
Female	8 (10)	3 (10)	5 (10)
Ethnicity			
Caucasian	65 (83)	22 (76)	43(88)
African American	2 (3)	1 (3.5)	1 (2)
Hispanic	3 (4)	1(3.5)	2 (4)
Native American	1(1)	0 (0)	1 (2)
Other	7 (9)	5 (17)	2 (4)
	Mean (SD)	Mean (SD)	Mean (SD)
Age	30.51(23–37)	32.31 (3.12)	29.31 (3.66)
Maternal Education	14.42(2.17)	14.69(2.15)	14.31 (2.20)
ADOS Severity Score	7.55 (1.74)	7.14 (1.45)	7.80 (1.86)
Bayley Cognitive Composite	84.36 (11.80)	90 (9.82)	81.02 (11.68)
Vineland Adaptive Behavior Scale	77.06 (8.37)	82.34 (7.41)	73.88 (7.28)
CDI-WG (Words Understood)	131.51(97.31)	202.59(90.45)	89.45 (74.56)
CDI-WG (Words Produced)	39.35 (67.5)	95.90 (84.90)	5.88 (5.36)

Note: ASD-L= ASD-Large vocabulary subgroup; ASD-S= ASD-Small vocabulary subgroup. ADOS = Autism Diagnostic Observations Schedule; CDI-WG = MacArthur Bates Communicative Developmental Inventory: Words and Gestures

Table 2

Total number of children who received each score on the respective measurement tools.

	ADOS			ESCS			CDI		
	ASD (n=78)	ASD-L (n=29)	ASD-S (n=49)	ASD (n=78)	ASD-L (n=29)	ASD-S (n=49)	ASD (n=78)	ASD-L (n=29)	ASD-S (n=49)
<i>Point</i>									
1	37	6	31	59 (BR) 68 (JA)	14 (BR) 19 (JA)	45 (BR) 49 (JA)	28	3	25
2	38	21	17	6 (BR) 6 (JA)	5 (BR) 6 (JA)	1 (BR) 0 (JA)	35	19	16
3	3	2	1	13 (BR) 4 (JA)	10 (BR) 4 (JA)	3 (BR) 0 (JA)	15	7	8
<i>Show</i>									
1	42	9	33	72	24	48	16	3	13
2	25	13	12	1	0	1	38	11	27
3	11	7	4	5	5	0	24	15	9
<i>Give</i>									
1	7	1	6	11	2	9	7	0	7
2	53	20	33	9	1	8	40	14	26
3	18	8	10	58	26	32	31	15	16

Note. ADOS= Autism Diagnostic Observation Schedule; CDI= MacArthur-Bates Communicative Development Inventory: Words and Gestures; ESCS = Early Social Communication Scale; BR= Behavior Regulation; JA= Joint Attention; ASD-L= ASD-Large vocabulary subgroup, ASD-S= ASD-Small vocabulary subgroup.

Table 3

Correlations between giving, pointing, and showing on the ADOS, CDI-WG, and ESCS.

Gesture Type/Instrument	1.	2.	3.	4.
ASD sample (N=78)				
<i>Point</i>				
1. ADOS	-	.22*	.43**	.47**
2. ESCS- JA		-	.30**	.25*
3. ESCS- BR			-	.23*
4. CDI-WG				-
<i>Show</i>				
1. ADOS	-	.32**	.06	
2. ESCS			-.09	
3. CDI-WG			-	
<i>Give</i>				
1. ADOS	-	.11	.22	
2. ESCS		-	.24*	
3. CDI-WG			-	
ASD-L Subgroup (n=29)				
<i>Point</i>				
1. ADOS	-	.07	.13	.18
2. ESCS - JA		-	.05	.18
3. ESCS-BR			-	-.24
4. CDI-WG				-
<i>Show</i>				
1. ADOS	-	.53**	-.17	
2. ESCS		-	-.22	
3. CDI-WG			-	
<i>Give</i>				
1. ADOS	-	.18	-.07	
2. ESCS		-	.35	
3. CDI-WG			-	
ASD-S Subgroup (n=49)				
<i>Point</i>				
1. ADOS	-	.43**	.47**	
2. ESCS- BR		-	.33*	
3. CDI-WG			-	
<i>Show</i>				
1. ADOS	-	-.01	.04	
2. ESCS		-	-.20	
3. CDI-WG			-	
<i>Give</i>				

Gesture Type/Instrument	1.	2.	3.	4.
1. ADOS	-	.05	.33*	
2. ESCS		-	.13	
3. CDI-WG			-	

Note.

**
p< .01,

*
p< .05;

ADOS= Autism Diagnostic Observation Schedule; CDI= MacArthur-Bates Communicative Development Inventory: Words and Gestures; ESCS = Early Social Communication Scale; ASD-L= ASD-Large vocabulary subgroup, ASD-S= ASD-Small vocabulary subgroup.