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BRIEF REPORT

Brief Report: High and Low Level Initiations of Joint Attention, and Response to Joint Attention: Differential Relationships with Language and Imitation

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Abstract Frequency of high-level (showing/pointing) and low-level (coordinated gaze shifts) behaviors on the Early Social Communication Scales are often used as a measure of joint attention initiations (IJA). This study examined the degree to which these skills and response to joint attention (RJA; e.g. gaze following) were differentially related to measures of language and imitation in 53 children with autism spectrum disorder between the ages of 22 and 93 months. High-level and low-level IJA were not associated with each other, and only high-level IJA was associated with RJA, and language and imitation measures. High-level IJA and RJA were unique predictors of imitation, while RJA was a unique predictor of language. Findings indicate that IJA involves distinct skills, with high-level behaviors more closely related to social-communication skills.

Keywords Joint attention · Autism spectrum disorder · Imitation · Language · ESCS

Introduction

Research has emphasized the importance of social communication deficits as an early marker of autism spectrum disorder (ASD). Within this literature, there has been a focus on the specific role of joint attention deficits, or deficits in coordinated attention with a social partner. Research studies have emphasized that children with ASD demonstrate less joint attention behaviors from an early age, and that these deficits distinguish them from their typically developing peers and peers with intellectual disabilities (Carpenter et al. 2002; Charman 1998; Dawson et al. 1998; Leekman et al. 2000; MacDonald et al. 2006; Mundy et al. 1986; Paparella et al. 2011). Additionally, theories of ASD suggest that the observed joint attention deficits associated with the disorder may be markers of core social motivational deficits that result in decreased social engagement and, thus, decreased social cognitive development (Mundy and Crowson 1997). This theory is supported by evidence that joint attention skills are associated with social and cognitive development in typically developing children (Beuker et al. 2013), as well as children with ASD (Baron-Cohen 1989; Mundy et al. 1986, 2010). For example, in children with ASD, joint attention is positively correlated with language and imitation ability (e.g., Beuker et al. 2013; Charman 2003; Mundy and Gomes 1998; Toth et al. 2006), and moderates the relationship between early intervention and language outcomes (Bono et al. 2004; Sullivan et al. 2007). These findings underscore the crucial role that joint attention deficits play in ASD, and have prompted the creation of interventions that specifically target joint attention as a means to improve a variety of social and cognitive skills (Kasari et al. 2006, 2008; Whalen and Schreibman 2003).

Despite the importance of joint attention deficits broadly for children with ASD, research has also demonstrated that different forms of joint attention, such as responding to joint attention (RJA) and initiating joint attention (IJA), are distinct skills that are not necessarily related to the same developmental outcomes. In particular, a number of studies have found that RJA is a stronger predictor of language development in children with ASD than IJA (e.g., Bono

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et al. 2004; Schietecatte et al. 2012). Other studies have emphasized the strong role that IJA plays in predicting imitation skills in children with ASD (e.g., Hobson and Hobson 2007; Rogers et al. 2003). However, these findings have not been consistent, with other studies suggesting that IJA may be an equally important predictor of language in children with ASD, and that RJA may also be a predictor of imitation in children with ASD (Luyster et al. 2008; Toth et al. 2006).

Because joint attention skills are so highly associated with the core social communication deficits observed in children with ASD (Mundy et al. 1986; Mundy and Crowson 1997), accurately defining and measuring joint attention behaviors are of critical importance. The *Early Social Communication Scales* (ESCS; Siebert et al. 1982) is a frequently used measure of joint attention that assesses several subsets of joint attention behavior, including RJA (following proximal and distal points), low-level IJA (coordinated gaze shifts between an object/event and person), and high-level IJA (shows and points). Research studies using the ESCS typically distinguish between RJA and IJA (e.g., Roos et al. 2008); however, they have not been consistent in the way that they have quantified IJA behaviors. Many studies using the ESCS have used a summary of high- and low-level IJA behaviors as their measure of IJA (e.g., Dawson et al. 2004; Toth et al. 2006), although some studies have distinguished between IJA-LL and IJA-HL (e.g., Mundy et al. 1994; Schietecatte et al. 2012), or have used high-level IJA only as a measure of IJA behavior (e.g., Rogers et al. 2003; Van Hecke et al. 2007).

The variation in quantifying IJA behavior across studies is important given that IJA-HL and IJA-LL may be measures of two distinct behaviors. IJA-HL is often thought to be indicative of the spontaneous sharing of experiences and attention with another person and may involve more social motivation (Mundy and Crowson 1997). In contrast, IJA-LL is thought to involve monitoring of another person's attention and may not require the same degree of social communication (Mundy et al. 1986; Siebert et al. 1982). This behavioral distinction between IJA-HL and IJA-LL may have important implications. In particular, research has demonstrated that protodeclarative pointing, a skill encompassed by IJA-HL, may be a precursor to the development of other critical social communication skills, including theory of mind (Baron-Cohen 1989). Additionally, research studies have demonstrated that deficits in IJA-HL, and not IJA-LL, are what differentiate children with autism from their typically developing peers, and that this specific behavior may be more predictive of social competence in young children with ASD (Charman 1998; Chiang et al. 2008; Van Hecke et al. 2007).

The emphasis on joint attention behavior as a marker of the social motivation deficits observed in children with ASD (Mundy and Crowson 1997) is important to consider given that research studies have varied in their conceptualization of IJA. Moreover, the different ways of quantifying IJA on the ESCS (total, high-level only, low-level only) across studies has led to mixed findings regarding the relationship between IJA and other social-communication skills in children with ASD. The goal of this study was to re-examine the relationship between joint attention on the ESCS and other social-communication behaviors in children with ASD, with a specific focus on the measurement of IJA. Because past research studies have suggested that IJA-HL may be a better representation of the core social motivation deficits observed in children with ASD, the current study predicted that IJA-HL would be more closely associated with measures of social communication, such as language and imitation (Mundy and Gomes 1998; Rogers et al. 2003).

Specifically, this study examined: (1) the degree to which low- and high-level IJA skills are related to each other; (2) whether low-level, high-level, and total scores of IJA are differentially related to RJA, language, and imitation ability for young children with ASD; and (3) the degree to which different joint attention behaviors uniquely predict language and imitation after controlling for age and ratio IQ.

Methods

Participants

Participants were 53 children with an ASD diagnosis between the ages of 22 and 93 months (mean = 44.79 months). All participating children received a clinical diagnosis of autistic disorder or pervasive developmental disorder-not otherwise specified based on DSM-IV-TR criteria (APA 2000) from a community provider and met the cut-off for autism or autism spectrum on the Autism Diagnostic Observation Schedule-Generic (Lord et al. 2000). The current study utilized preexisting assessment data that was obtained from a standardized battery that was performed at intake for a variety of IRB-approved research studies examining social communication development in young children with ASD.

Measures

Ratio IQ: Either the *Bayley Scales of Infant Development, 3rd Edition* (BSID-III; Bayley 2006; $n = 45$) or *Mullen Scales of Early Learning* (MSEL; Mullen 1995; $n = 8$) were used to derive a nonverbal intelligence quotient. The

MSEL was used to assess nonverbal intelligence in only eight of the participating children because these children were involved in a later research study in which there was a slight protocol shift so that the standard battery of assessments included the MSEL rather than the BSID-III. Both the BSID-III and the MSEL are standardized developmental assessments that yield age equivalent scores on various domains of cognitive development, including both verbal and nonverbal domains. The BSID-III is typically used with children between the ages of 1 and 42 months of age, while the MSEL is used with children between 1 and 68 months of age. Due to floor effects for many of the participants, a ratio IQ was obtained by dividing the child's age equivalent on the cognitive domain (BSID-III) or the average of the child's age equivalents on the visual reception and fine motor domains (MSEL) by the child's chronological age and multiplying by 100.

Joint Attention: The *Early Social Communication Scales* (ESCS; Siebert et al. 1982) was used to measure the children's ability to respond to and initiate joint attention bids. The ESCS uses a set of engaging toys and activities in order to examine children's ability to engage in social interaction with the examiner in a semi-structured interaction. RJA and IJA were coded from video by trained observers. IJA-HL was coded when the child: (1) pointed to a toy, with or without eye contact to the examiner; and (2) showed an object to an examiner while making eye contact. IJA-LL was coded when the child: (1) made eye contact with the examiner while using a toy; and (2) alternated eye contact between an active toy and the examiner. The frequency of IJA-HL and IJA-LL during the ESCS were scored independently and summed to produce an overall IJA score (IJA-Total). The percent of correct responses to 6 proximal and 8 distal points was used as a measure of RJA. Twenty-five percent of administrations were coded by a second independent observer. Kappa was used to calculate reliability for RJA, and yielded .81. Intraclass correlations were used to calculate reliability for all IJA measures. Reliability was .83 for IJA-LL, .81 for IJA-HL, and .83 for IJA-Total.

Language Skills: The *Preschool Language Scales, 4th Edition* (PLS-4; Zimmerman et al. 2002). Children received either the PLS-4 ($n = 45$) or the MSEL ($n = 8$) as a measure of receptive and expressive language ability. The 8 children received the MSEL due to a protocol shift in the standard battery of assessments that occurred in later research studies. The PLS-4 is a standardized language assessment for children from birth through 6 years, 11 months of age. Both the PLS-4 and the MSEL yield age equivalent scores for receptive and expressive language ability. All children received the *MacArthur-Bates Communicative Development Inventory* (MCDI; Fenson et al. 1993), a parent-report measure that asks parents about their child's receptive and expressive vocabulary. The number of words produced was used as a measure of the children's expressive vocabulary.

Imitation Skills: The *Motor Imitation Scale* (MIS; Stone et al. 1997) was used to measure the children's ability to imitate in a structured context (elicited imitation). The MIS consists of eight object imitation tasks and eight gesture imitation tasks that are scored on a 3-point scale. The *Unstructured Imitation Assessment-Object Scale* (UIA-O; Ingersoll and Meyer 2011) was used to measure the children's ability to imitate in an unstructured context (spontaneous imitation). The UIA-O consists of 10 object imitation tasks. Tasks are presented without explicit instruction to imitate and are interspersed with periods of contingent imitation. Although all children were administered the UIA-O, 17 children received a modified version of the UIA-O, containing only nine of the tasks. Thus, performance on the tenth imitation task was excluded for all children administered the original version of the UIA-O to keep scores consistent across participants. For both assessments, children received three opportunities to imitate each target action, and were scored for their best response for the three opportunities. Scores were converted to percent correct by dividing the obtained score by the total possible score. Cronbach's alpha was .95 for the MIS and .78 for the UIA-O, indicating good to excellent internal consistency. Reliability was calculated by two independent observers for 25 % of the study participants. Intraclass correlation coefficients for the MIS and UIA-O items yielded a reliability of .99 for the MIS and .98 for the UIA-O. See Table 1.

Results

The data were examined for normality. Most variables were normally distributed; however, the three IJA variables and chronological age were not. Thus, a square root transformation was conducted on these four variables prior to data analysis to normalize their distribution. Bivariate correlations using a Bonferroni's correction ($.05/25 = .002$) were run between the joint attention, language, and imitation variables. When appropriate, we used the statistical approach outlined by Steiger (1980) to compare the difference between correlation coefficients for the different joint attention measures.

We first examined the relationship between the different forms of IJA and RJA using a Bonferroni's correction. As can be seen in Table 2, IJA-LL and IJA-HL were not significantly correlated ($r = .17$, $p = .42$). RJA was significantly correlated with IJA-HL ($r = .48$, $p < .001$), but not IJA-Total ($r = .31$, $p = .07$) or IJA-LL ($r = .16$, $p = .46$.). Next we examined the relationship between the different forms of joint attention and the language and imitation measures. IJA-HL was significantly associated

Table 1 Participant characteristics

	Mean	SD	Range
Chronological age (months)	44.79	13.77	22–93
Gender (% male)	85		
Ratio IQ (AE/CA age X 100; Bayley/Mullen)	52.51	18.38	20–96
Initiation of joint attention-low level (frequency; ESCS)	2.47	2.92	0–13
Initiation of joint attention-high level (frequency; ESCS)	.70	1.59	0–8
Initiation of joint attention-total (frequency; ESCS)	3.17	3.48	0–13
Response to joint attention (% correct; ESCS)	58.30	28.16	0–100
Receptive language (AE; PLS-4/Mullen)	18.57	10.08	4–46
Expressive language (AE; PLS-4/Mullen)	20.57	8.54	6–43
Expressive vocabulary (# words produced; MCDI)	157.59	181.22	0–628
Elicited imitation (% correct; MIS)	38.81	33.28	0–100
Spontaneous imitation (% correct; UIA-O)	32.70	26.14	0–94

AE age equivalent, *CA* chronological age

Table 2 Bivariate correlations of joint attention, language and imitation ability

	IJA-LL	IJA-HL	IJA-Total	RJA
Joint attention				
IJA-HL	.17			
IJA-Total	.92*	.51*		
RJA	.16	.48*	.31	
Language				
Receptive	.14	.44*	.27	.73*
Expressive	.15	.29	.22	.65*
Vocabulary	.18	.30	.25	.64*
Imitation				
Elicited	.10	.67*	.31	.73*
Spontaneous	.08	.51*	.23	.68*

Using a Bonferroni's correction, * $p < .002$

with measures of receptive language and all imitation measures (all rs $> .44$, all ps $< .001$), while IJA-LL was not significantly associated with any of them (all rs $< .18$, all ps $> .42$). IJA-Total was not significantly associated any of the language measures (all rs $< .27$, all ps $> .10$) or imitation measures (all rs $< .31$, all ps $> .04$). RJA was also significantly associated with all of the language and imitation measures (all rs $> .64$, all ps $< .001$), and was more strongly associated with each language measure than IJA-HL or IJA-Total, all ps $< .05$. RJA was also

Table 3 Joint attention as a predictor of language ability

Predictor	β	t	R^2	F change
Step 1			.60	36.54**
Chronological age	.62	6.67**		
Ratio IQ	.59	6.40**		
Step 2			.68	3.39*
Chronological age	.44	4.29**		
Ratio IQ	.42	3.92**		
IJA-LL	.07	.75		
IJA-HL	−.04	−.44		
RJA	.35	2.90**		

** $p < .01$, * $p < .05$

Table 4 Joint attention as a predictor of imitation ability

Predictor	β	t	R^2	F change
Step 1			.50	23.72**
Chronological age	.51	4.90**		
Ratio IQ	.56	5.41**		
Step 2			.71	10.77**
Chronological age	.26	2.76**		
Ratio IQ	.26	2.51*		
IJA-LL	−.03	−.37		
IJA-HL	.32	3.39**		
RJA	.36	3.12**		

** $p < .01$, * $p < .05$

significantly more strongly associated with elicited imitation than IJA-Total, $p < .001$. Excluding the eight participants who were administered the Mullen instead of the PLS-4 did not significantly alter the results. Similarly, excluding the 17 children administered the modified version of the UIA-O did not change the present findings.

Next, we ran two hierarchical linear regression models to examine which joint attention behaviors (IJA-LL, IJA-HL, and RJA) best predicted language and imitation skills. To do this, we z-scored the three language measures (receptive, expressive, and vocabulary) and the two imitation measures and summed them to create a composite language and a composite imitation variable. For both models, chronological age and ratio IQ were entered in the first step and IJA-LL, IJA-HL, and RJA were entered in the second step (IJA-Total was not included as it represented a summary score of IJA-LL and IJA-HL). RJA was a unique predictor of language ($\beta = .35$, $p < .01$), with the final model explaining 68 % of the variance in language. See Table 3. Both IJA-HL ($\beta = .32$, $p < .01$) and RJA ($\beta = .36$, $p < .01$) were unique predictors of imitation, with the final model predicting 71 % of the variance in imitation. See Table 4. Finally, we reran both models using

the IJA-Total score in place of the IJA-LL and IJA-HL scores. The amount of variance explained by the model remained similar ($r^2 = .67$) for language; however, the amount of variance explained by the model decreased ($r^2 = .64$) for imitation, and IJA-Total was not a unique predictor of imitation.

Discussion

Like prior research, the current study found that joint attention on the ESCS was positively associated with measures of language and imitation ability in children with ASD. The current study also examined both low- and high-level IJA behaviors separately, as well as together as a total IJA score. By doing so, it was found that IJA-HL was significantly associated with RJA, language, and imitation, while IJA-LL was not. As a result, combining IJA-HL and IJA-LL into a composite measure of IJA removed many of the significant associations that were present between IJA-HL and language and imitation measures. Perhaps even more importantly, IJA-HL and IJA-LL were not significantly associated with each other.

In addition, after controlling for chronological age and ratio IQ, RJA remained a unique predictor of the composite language variable, and RJA and IJA-HL both remained unique predictors of the imitation composite. Although the final model containing RJA, IJA-HL and IJA-LL in this study only explained an additional eight percent of the variation in language ability, we consider this finding to be clinically significant. Previous research demonstrating stronger relationships between joint attention and language ability have typically examined first order correlations, and have not controlled for nonverbal IQ (e.g., Bono et al. 2004; Schietecatte et al. 2012). Thus, our more conservative approach yields similar findings regarding the relationship between joint attention and language in children with ASD. The current results are also consistent with previous research indicating that RJA is more closely associated with language skills than IJA (Schietecatte et al. 2012). They also suggest that both IJA and RJA are independent predictors of imitation skills, although this finding was only evident for high-level IJA behavior; when the IJA-Total score was used instead of IJA-LL and IJA-HL, IJA was not a significant predictor of imitation skills.

The current study underscores prior literature advocating for the differentiation between IJA-HL and IJA-LL, and that has emphasized that IJA-HL may be a particularly important precursor to the development of social communication skills (Baron-Cohen 1989; Mundy et al. 1994). Specifically, our findings suggest that IJA-LL and IJA-HL are two distinct sets of behavior that are minimally correlated, and that are differentially associated with other social communication skills. This finding is consistent with research studies that have documented the differential relationship between IJA-HL, IJA-LL and other social communication variables (Chiang et al. 2008; Mundy et al. 1994; Schietecatte et al. 2012; Van Hecke et al. 2007). This finding is also consistent with research that has found these skills to respond differentially to intervention. For example, IJA-LL gains are seen across a wide array of interventions including those that specifically target joint attention (Kasari et al. 2006, 2008), but also those that target other behaviors such as symbolic play and imitation (Ingersoll and Schreibman 2006; Kasari et al. 2006). On the other hand, gains in IJA-HL appear to be unique to interventions that specifically target children's ability to initiate joint attention using pointing and showing (Kasari et al. 2006; Whalen and Schreibman 2003).

Although this is not the first study to demonstrate the importance of IJA-HL, the results of the current study emphasize the particular importance of higher level joint attention skills in predicting language and imitation in children with ASD. The critical importance of IJA-HL in comparison to IJA-LL may reflect core differences in the behaviors the two measures reflect. Specifically, IJA-LL likely reflects checking and monitoring behavior, a behavior that does not necessarily distinguish children with ASD from their developmentally delayed peers (Mundy et al. 1986). On the other hand, IJA-HL may better reflect social motivation, a behavior that is hypothesized to underlay joint attention and social cognitive development (Hobson and Hobson 2007; Mundy and Crowson 1997). This hypothesis is supported by the fact that previous research studies that have demonstrated that IJA-HL is the only joint attention behavior that differentiates children with autism from their typically developing peers (Charman 1998; Chiang et al. 2008). Given that IJA-HL appears to be a better representation of the joint attention and social motivational deficits seen in children with ASD, future intervention research should specifically target social engagement and social motivation as a means to increase joint attention behavior, and the higher level social communicative skills that develop in association with joint attention.

Although prior research has documented significant relationships between composite measures of IJA and a wide array of language and imitation measures (e.g., Johnson et al. 2012; Roos et al. 2008), these associations have also been mixed (Johnson et al. 2012; Schietecatte et al. 2012; Toth et al. 2006). In part, these mixed findings may be due to the tendency to combine two distinct sets of IJA behavior into one broad composite score. Indeed, the current study demonstrated that combining IJA-HL and IJA-LL into IJA-Total weakens the relationship between IJA and language and imitation measures. The current

study results thus raise concerns about the validity of composite measures of IJA throughout social communication literature within the ASD field.

There are several limitations to consider with the current study. First, there was variation in the assessments used to measure cognitive and language ability, as well as a modification to the administration of the measure of spontaneous imitation ability. Although excluding participants who were administered the Mullen and the modified UIA-O did not change the findings, additional research using a singular test battery would strengthen the conclusions. Given the focus on IJA behavior, it appeared less critical to distinguish specific RJA behaviors. However, this is a notable limitation of the current study. Although the sample size for this study was larger than many studies of social communication skills in young children with ASD, a larger sample size may have enhanced the generalizability of the results of the current study. In addition, due to the exploratory nature of the study, the primary aim of the study was to determine how specific joint attention behaviors relate to one another in children with ASD. Future research should further address whether these subsets show similarly distinct relationships with other social-communication skills longitudinally and in children with typical development or non-ASD related developmental concerns.

In summary, the current study demonstrated that IJA-LL and IJA-HL are distinct forms of joint attention behavior that are differentially related to measures of language and imitation ability, and are not significantly correlated with each other. Although consistent with existing literature that has examined IJA-HL and IJA-LL separately (Mundy et al. 1994; Van Hecke et al. 2007), the findings are particularly critical given that research within the ASD field continues to combine IJA-LL and IJA-HL into composite scores of IJA. The current study suggests that future research should distinguish between IJA-LL and IJA-HL in order to more clearly demonstrate the specific relationship between IJA and key developmental behaviors in young children with ASD.

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