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Short report: Response to joint attention and object imitation as predictors of expressive and receptive language growth rate in young children on the autism spectrum

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Abstract

Joint attention and imitation are thought to facilitate a developmental cascade of language and social communication skills. Delays in developing these skills may affect the quality of children's social interactions and subsequent language development. We examined how responding to joint attention and object imitation skills predicted rate of expressive and receptive communication growth rate in a heterogeneous sample of autistic children. Children's baseline skills in responding to joint attention uniquely predicted expressive, but not receptive, language growth rate over time, while object imitation did not significantly predict language growth rate over and above joint attention skills. Future research should examine the potential moderating roles of child age and developmental level in explaining associations between joint attention and object imitation and later language development.

Keywords

joint attention; imitation; communication; language; autism

Early developmental skills, such as joint attention and imitation, enable children to participate in social interactions that support the development of language and communication skills. When children respond to joint attention cues, such as following another person's gaze, point or spoken language bids, they shift their attention to that person's point of reference. This skill helps children map their partner's speech to their environment, therefore linking language to meaning (Bottema-Beutel, 2016). Similarly, when children imitate or copy actions and play, they socially orient to others and engage in skills such as turn taking, role reversal, and sharing information. Thus imitation serves as a

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tool for social communication exchange that facilitates language development and reciprocal communication (Carpenter et al., 2002; Nadel et al., 2004; Toth et al., 2006).

Young children on the autism spectrum may have significant difficulties responding to joint attention and engaging in imitative behaviors (Mundy et al., 1990; Nadel, 2002; Rogers & Pennington, 1991). Previous research has shown that autistic children show decreased responsivity to social bids (i.e. gaze, points; Dawson et al., 2004) and imitate less frequently and accurately than non-autistic peers (Nadel, 2002). Developmental delays in responding to joint attention or engaging in imitation attenuate a child's ability to attend and respond to social signals, which have rippling effects on the development of subsequent skills such as understanding (i.e., receptive language) and producing language (i.e. expressive language; Luyster et al., 2008; Toth et al., 2006). As such, understanding the role of joint attention and imitation in facilitating language growth over time has implications for understanding how best to support communication development in autistic youth (Bottema-Beutel et al., 2021; Thurm et al., 2015).

Developmental theories of language acquisition posit that social interaction is a critical factor in language growth (Kuhl, 2007). The ability to orient attention to social signals and maintain social engagement – key components in both joint attention and imitation skills– impacts a child's motivation to participate in social interactions that elicit language input from caregivers or peers, which in turn enhance receptive and expressive language growth (Franchini et al., 2017). Understanding the role of early developmental skills, such as joint attention and imitation, is important when developing intervention targets for receptive and expressive language skills, given the variation in language abilities among children on the autism spectrum (Tager-Flusberg et al., 2005).

There is considerable support for a positive association between responding to joint attention (RJA) cues and concurrent (Dawson et al., 2004; Murray et al., 2008) and later (Charman, 2003; Sigman et al., 1999) language skills in autistic children. Concurrently, the ability to respond to joint attention bids is correlated with both receptive and expressive language skills in children with autism (Murray et al., 2008). Longitudinal examinations have also shown that RJA is predictive of later receptive language ability (Thurm et al., 2007) and expressive language skills (Mundy & Gomes, 1998). Supporting the idea that RJA may actively facilitate language development, one study found a relationship between intervention dose and gain in language skills only for a subset of children with particularly high levels of RJA (Bono et al., 2004). This suggests that RJA enables children to benefit from language-learning opportunities provided in intervention contexts. Accordingly, joint attention is a focal intervention target in some early interventions (Kasari et al., 2006; Whalen et al., 2006).

Previous correlational research has also supported the relationship between imitation skills and spoken language skills in autistic children both concurrently (Ingersoll & Meyer, 2011; Luyster et al., 2008) and longitudinally (McDuffie et al., 2005; Thurm et al., 2007). Engaging in frequent imitative behaviors, including imitating motor actions (Stone & Yoder, 2001), object play (Charman et al., 2000), gestures (Stone et al., 1997), and vocalizations (Thurm et al., 2007), is associated with later expressive language skills.

Further, a recent parent-mediated intervention study with high-risk infant siblings found gains in motor imitation mediated the relationship between the intervention and gains in intentional communication, suggesting that imitation may influence language development within an intervention context (Yoder et al., 2021). Accordingly, imitation is also a focal intervention target in some early interventions (Ingersoll & Dvortcsak, 2010; Ingersoll & Schreibman, 2006).

Research examining the relationship between responding to joint attention, imitation, and language skills has been largely correlational. Relatively few studies have examined joint attention and imitation skills simultaneously as predictors of *growth rate* of language skills in young children on the autism spectrum. Toth and colleagues (2006) examined this relationship in a sample of 34 to 52-month-old children using multilevel linear modeling and found that deferred imitation (i.e., imitating an action after a delay), but not joint attention, was uniquely predictive of higher rates of language growth over time. Similarly, Yoder and colleagues (2015) examined this relationship in a sample of 24 to 48-month-old children. However, results revealed that RJA, but not imitation, was uniquely predictive of both receptive and expressive language growth.

The current study examines both RJA and imitation as predictors of expressive and receptive language growth over 9 months using multilevel linear growth models. Given the divergent results in previous research (e.g. Toth et al., 2006; Yoder et al., 2015), we examined this question in a heterogenous sample of autistic youth, representing a relatively wide range of age and extent of expressive communication delays.

Method

Data for this study come from a completed pilot randomized controlled trial (RCT) and an ongoing full-scale RCT (Ingersoll, Wainer, Berger, Pickard, & Bonter, 2016) of a parent-mediated, social communication intervention. Inclusion criteria for the two studies were identical, with the exception that the second trial expanded the eligible age range to include children up to 8 years old (compared to 6 years old in the pilot study). All families in this sample received access to an online parent-mediated intervention program targeting child social communication skills, either with the support of a coach or in a self-directed format (Ingersoll & Dvortcsak, 2010). Informed consent was obtained from all families prior to their participation in the research.

Participants

Participants in this study were 65 children who were 18 to 93 months old (Table 1) and a primary caregiver. All children in the study had a diagnosis of autism spectrum disorder or suspected autism and presented with limited language skills (i.e. an expressive language age equivalent of less than 4 years at study entry). Children were evaluated on several measures at three time points: study entry (Time 1), Time 2 (4-6 months later), Time 3 (3 months after Time 2). Participant demographics and other developmental characteristics are provided in Table 1.

Measures

Developmental functioning—Assessments at intake were used to characterize children's cognitive ability and autism symptomatology. The Autism Diagnostic Observation Schedule, 2nd edition (ADOS-2; Lord et al., 2012), was administered to determine study eligibility and provide a baseline estimate of autism characteristics. Modules T, 1, or 2 were administered based on child age and expressive language skills. The Calibrated Severity Score (CSS), ranging from 1-10, provides an estimate of autism symptomatology independent of age and language level.

The Mullen Scales of Early Learning (MSEL; Mullen, 1995) were administered in order to assess child cognitive ability. A nonverbal developmental quotient was calculated using age equivalent scores from the Fine Motor and Visual Reception subscales using the following formula: (average of fine motor and visual reception age equivalent scores)/ chronological age* 100. Scores above 100 represent more advanced cognitive ability relative to chronological age expectations, while scores lower than 100 indicate cognitive impairment relative to chronological age expectations.

Language skills—Expressive and receptive language were measured using the expressive language and receptive language subscale raw scores from the Vineland Adaptive Behavior Scales, 2nd edition (VABS). The VABS is a standardized structured caregiver interview that measures adaptive behaviors across a variety of developmental domains, including communication skills (Sparrow et al., 2005). Raw scores were used rather than standard scores to serve as an estimate of child skills, rather than child skills compared to same-age peers, due to the wide range of age and communication functioning in this sample.

Response to joint attention—An abbreviated version of the Early Social Communication Scales (ESCS), an observational measure of joint attention skills, provided an estimate of children's ability to respond to joint attention bids from an adult (Mundy et al., 2003). Specifically, the RJA score represents the percentage of adult points that the child followed to both proximal and distal targets (range 0-100%). Within our heterogeneous sample, RJA was significantly correlated with baseline chronological age (r=.446, p<.001) but not nonverbal developmental quotient (r=.245, p=.062).

Object imitation—A play-based observational imitation assessment, the Unstructured Imitation Assessment (Ingersoll & Meyer, 2011), was used to determine object imitation skills (see Ingersoll & Meyer, 2011 for full list of task materials and actions). The task has previously demonstrated good reliability and internal consistency (Pickard & Ingersoll, 2015). While playing with the child, an unfamiliar adult modeled a standardized set of play actions in an effort to elicit object imitation. Children received three opportunities to imitate each modeled action and were scored on the best response for each action. The adult interspersed play models between periods of contingent imitation. Children were given no explicit instructions during the task. Children received 1 point for partial imitation and 2 points for full object imitation across a series of trials with 10 objects. A subset of children (n=26) received a modified version of the task, containing 9 rather than 10 objects. An overall object imitation score was calculated by summing the total number of points earned, dividing by the total possible points and multiplying by 100, such that children's scores were not decremented for the object they were not shown. In our sample, object imitation score was significantly correlated with nonverbal developmental quotient (*r*=.309, *p*=.019) but not chronological age (*r*=.245, *p*=.062).

Analysis plan

Multilevel linear growth models using restricted maximum likelihood estimation were used to examine the effects of RJA and object imitation skills on expressive and receptive language skills over time, controlling for chronological age and nonverbal developmental quotient. Because RJA and baseline object imitation skills were highly correlated (*r* = .48), we first ran separate models for RJA and the time*RJA interaction (Model 1) and object imitation and the time*object imitation interaction (Model 2) so as to understand their individual relationships with expressive and receptive language growth. Time, chronological age, nonverbal developmental quotient, and either baseline RJA or baseline object imitation skills were included as fixed main effects. Interaction terms were used to estimate the effect of our primary predictors of interest on language growth rate (i.e., slope). Variance due to individual differences in child language skills (i.e., intercept variance) and residual variance were included as random effects. Then, we ran a full model (Model 3) including both RJA and object imitation, and their respective interaction terms. Time since study entry and chronological age were both coded in months and all predictor variables were grand-mean centered prior to analysis. Additional follow up analyses for each of the above models were run as applicable. Simple slopes analyses (using +/− 1 standard deviation) were used to clarify the nature of significant interaction effects. Pseudo-R^2 and χ^2 deviance tests were used to estimate the proportion of variance explained and the statistical significance of our primary variables of interest, respectively, over and above control variables.

Results

Expressive language

First, we ran a model investigating the effects of RJA and the time*RJA interaction on expressive language growth (Table 2 Model 1). Fixed effects of time, chronological age, nonverbal developmental quotient, RJA, and the time*RJA interaction were all statistically significant. Simple slopes analyses showed that children with higher levels of RJA (1 SD above the mean) had higher average expressive communication raw scores over time (Intercept = 48.08) and improved more quickly than children with low levels of RJA (1 SD below the mean; Intercept = 35.22). For a 1-month increase in time, children with high levels of RJA had a 2.03 point increase in expressive language raw score (b = 2.03, SE = .209, t(97) = 9.739, p<.001), while children with low levels of RJA had a .81 point increase in expressive language raw score (b = .809, SE = .204, t(95) = 3.966, p<.001). The addition of RJA and the time*RJA interaction accounted for 15.8% of the variance in expressive language, over and above the effects of time, age, and nonverbal cognitive ability (pseudo R^2 = .158). A deviance test using maximum likelihood estimation was used to compare a constrained model (i.e., with fixed effects of time, age, and nonverbal developmental quotient only) and the full model which included RJA and the time*RJA interaction. The constrained model had significantly worse model fit compared to the full model, $\chi^2(2) = 24.60$; thus, the variance accounted for by RJA and the time*RJA interaction was statistically significant.

Next, we ran a model with fixed effects of time, chronological age, nonverbal developmental quotient, object imitation and the time*object imitation interaction (Table 2 Model 2). The fixed effects of time, age, and nonverbal developmental quotient remained significant. There was no significant main effect of object imitation; however, there was a significant time*object imitation interaction. Thus, children with more advanced object imitation at baseline improved more in terms of expressive language skills over the course of the study. Simple slopes analyses showed that children with higher levels of object imitation (1 SD above the mean; intercept = 44.09) had higher average expressive communication raw scores over time and improved more quickly than children with low levels of object imitation (1 SD below the mean; intercept = 36.80). For a 1-month increase in time, children with high levels of object imitation had a 1.80 point increase in expressive language raw score (b = 1.804, SE = .204, t(91) = 8.859, p<.001), compared to a .94 point increase for children with low levels of object imitation (b = .938, SE = .226, t(91) = 4.140, p<.001). The addition of baseline object imitation and the time*object imitation interaction accounted for 8.5% of the variance in expressive language, over and above the effects of time, age, and nonverbal cognitive ability (pseudo $R^2 = .085$). A deviance test (as described above) showed that the constrained model had significantly worsened model fit compared to the full model, $\chi^2(2) = 11.37$; thus, the variance accounted for by object imitation and the time*object imitation interaction was statistically significant.

Last, in a combined model predicting expressive language growth, the fixed effects of time, chronological age, nonverbal developmental quotient, RJA, and the time*RJA interaction were all statistically significant, while object imitation and the time*object imitation interaction were not (Table 2 Model 3).

Receptive language

When RJA and object imitation were examined separately, we found a significant main effect of RJA, such that children with more advanced RJA skills also had higher receptive language raw scores (Table 3 Model 1). However, the time*RJA interaction was not significant. Thus, RJA did not predict rate of receptive language growth over the duration of the study. Neither the main effect of object imitation nor its interaction with time were statistically significant (Table 3 Model 2). Results of our combined model for receptive language show the fixed effects of time, chronological age, and nonverbal developmental level were statistically significant in the expected direction (Table 3 Model 3), while RJA, object imitation, and their respective interaction terms did not significantly predict receptive language.

Discussion

This study replicated a previous finding that for children on the autism spectrum who are early language learners, RJA is predictive of faster expressive language growth over time, over and above baseline object imitation and other child characteristics (Yoder et al., 2015). Although baseline object imitation also predicted rate of expressive language growth over time in our sample, this relationship was no longer present when RJA was added to the model. This is consistent with previous research suggesting that object imitation does not uniquely predict communication, perhaps because of its high intercorrelation with other relevant predictors (Yoder et al., 2015).

Understanding the role of object imitation in predicting communication growth is further complicated by differences in measurement across studies. Different types of imitation tasks have been shown to correlate concurrently with different developmental skills (Ingersoll & Meyer, 2011). Our study used a measure of spontaneous, immediate object imitation. In similar analyses, some researchers have used an imitation task where the child was given a direct verbal cue to imitate (e.g. Yoder et al., 2015), while others have examined immediate and deferred imitation separately (e.g. Toth et al., 2006). Additional studies have examined imitations of body movements and actions with objects separately (e.g. Stone et al., 1997). It is possible that deferred (vs. immediate) imitation or imitation of body movements (vs. actions with objects) are important predictors of rate of child language growth (Toth et al., 2006).

Surprisingly, RJA did not predict rate of receptive language growth in our sample. However, children with better RJA skills had better receptive language skills on average; this replicates a body of correlational research between the two but is not necessarily supportive of a facilitative role of RJA on the rate of later receptive language growth. This result is consistent with previous findings in a sample with a similar average chronological age and developmental level to ours (Toth et al., 2006). In a younger sample of children, Yoder and colleagues found that RJA uniquely predicted receptive (and expressive) language growth. The association between key developmental skills and receptive and expressive language growth likely varies at different developmental stages. Indeed, Van der Paelt and colleagues (2014) found that imitation was positively associated with expressive language skills in both early and more advanced language learners, while RJA was positively associated with expressive language growth only in early language learners. The ability to respond to another person's joint attention cues, such as following another person's gaze or point, provides referential cues that map adult speech to the surrounding environment, which in turn facilitate word learning. These cues may be important for learning first words (e.g. via "fast mapping;" McDuffie et al., 2006); however, once children surpass a certain threshold in their language development, other factors (e.g. the richness and complexity of the child's language environment; Hoff & Naigles, 2002) may become more predictive of receptive language growth rate over time as children learn more complex linguistic relationships and functional language.

Limitations

There are several limitations to the current study. The heterogeneity of our sample – in particular, the wide range of chronological age and cognitive ability – limits the conclusions that can be drawn about these relationships at specific developmental stages. It is possible that the relations among joint attention, object imitation, and communication vary systematically by child age and extent of developmental delay. Although we controlled for age and developmental quotient in our analyses, due to the sample size and number of observations in this study, we were not able to directly compare our results for different age groups or conduct a moderation analysis. It is also possible that older children respond differently from very young children on tasks such as the Unstructured Imitation Assessment or the Early Social Communication Scales. Future research on the measurement properties of these instruments is needed to better understand their validity for children of different ages. Last, the children in our sample were accessing a wide range of community and school-based services during (and presumably, prior to) the study period, which potentially confounds our results. For example, it is possible that children who accessed more, high-quality services during or before participating in this study also had stronger joint attention skills.

Conclusion

Most early research on the relationship between joint attention, imitation, and child language development in autistic children was correlational in nature and did not examine growth rates over time. More recent work has begun to examine growth trajectories, and we believe replication of these results is important, particularly in light of heterogeneity in samples across studies. Differing roles of joint attention and imitation at different stages of child development may explain why our findings replicate some previous findings while diverging from others. Future research which directly examines moderators of the relationship between language growth and joint attention and imitation skills in a heterogeneous sample are a necessary next step to better understand these relationships.

In a clinical context, our results speak to the utility of targeting a combination of joint attention and imitation in addition to language skills in order to best support early social communication growth in children on the autism spectrum. In particular, teaching parents to support their children's development in these domains by increasing parent verbal responsiveness (Edmunds et al., 2019) and contingent imitation (Gulsrud et al., 2016) may provide children with many natural learning opportunities that simultaneously support the development of more advanced social communication skills. Such an approach is consistent with naturalistic developmental behavioral interventions (NDBIs), which are meant to facilitate growth of developmental skills in the context of natural, playful social interactions (Schreibman et al., 2015). Future research examining the age and developmental stages for which different types of joint attention and imitation skills support language growth would enable optimization of the timing and delivery of such interventions using a data-driven approach to developing individualized treatment goals.

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Conflict of interest disclosure:

Dr. Brooke Ingersoll is a co-developer of Project ImPACT, an early intervention program for young children with social communication delays. She receives royalties from Guilford Press for the curriculum and fees for training others in the program. Dr. Ingersoll donates profits from this work to support research and continued development of Project ImPACT. Kyle Frost is involved with training providers to implement Project ImPACT at fidelity, and is currently supported by an NIH grant to study how Project ImPACT works. Anamiguel Pomales-Ramos has no conflicts of interest to report.

Data accessibility statement:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Table 1

Child demographics and developmental characteristics.

		N	%
Parent-reported Sex			
Male		45	69.2
Female		20	30.8
Race			
White		46	70.8
Black or African American		6	9.2
Asian		3	4.6
More than one race		9	13.8
Other race		1	1.5
	Mean	**SD**	**Range**
Chronological age (months)	44.85	15.86	17.7-93.2
Nonverbal developmental quotient	59.20	19.67	19.37-98.7
Verbal developmental age (months)	20.69	10.13	6.0-42.5
Nonverbal developmental age (months)	25.17	9.64	9.5-57.5
ADOS Calibrated Severity Score	6.80	1.47	4-10

Note. ADOS = Autism Diagnostic Observation Schedule.

Table 2

Multilevel linear growth models with RJA and object imitation predicting expressive language scores.

Parameter	Estimate	SE	df	t	p
Model 1: RJA only					
Intercept	41.651	1.742	58	23.91	<0.001
Time	1.422	0.146	97	9.71	<0.001
Chronological Age	0.5	0.151	57	3.30	0.002
NVDQ	0.461	0.109	58	4.21	<0.001
RJA	0.227	0.074	59	3.08	0.003
RJA*Time	0.022	0.005	96	4.22	<0.001
Model 2: Object imitation only					
Intercept	40.443	1.830	54	22.09	<0.001
Time	1.371	0.158	91	8.70	<0.001
Chronological Age	0.671	0.141	53	4.75	<0.001
NVDQ	0.546	0.121	54	4.53	<0.001
Object Imitation	0.153	0.090	53	1.70	0.095
Object Imitation*Time	0.018	0.006	91	2.95	0.004
Model 3: Full model					
Intercept	40.755	1.808	52	22.54	<0.001
Time	1.433	0.155	88	9.24	<0.001
Chronological Age	0.516	0.157	51	3.29	0.002
NVDQ	0.493	0.122	52	4.03	<0.001
RJA	0.19	0.082	52	2.33	0.024
RJA*Time	0.019	0.007	88	2.95	0.004
Object Imitation	0.080	0.094	52	0.85	0.400
Object Imitation*Time	0.007	0.007	88	0.97	0.335

Note. NVDQ = nonverbal developmental quotient; RJA = response to joint attention.

Table 3

Multilevel linear growth models with RJA and object imitation predicting receptive language scores.

Parameter	Estimate	SE	df	t	p
Model 1: RJA only					
Intercept	21.248	0.615	59	34.54	<0.001
Time	0.577	0.075	100	7.70	<0.001
Chronological Age	0.161	0.053	57	3.03	0.004
NVDQ	0.097	0.039	59	2.51	0.015
RJA	0.080	0.026	59	3.06	0.003
RJA*Time	− 0.003	0.003	99	− 1.22	0.227
Model 2: Object imitation only					
Intercept	20.981	0.617	53	34. 0	<0.001
Time	0.597	0.076	93	7.87	<0.001
Chronological Age	0.225	0.047	52	4.73	<0.001
NVDQ	0.126	0.041	54	3.09	0.003
Object Imitation	0.050	0.030	52	1.64	0.108
Object Imitation*Time	− 0.003	0.003	93	− 0.93	0.354
Model 3: Full model					
Intercept	21.097	0.605	52	34.87	<0.001
Time	0.595	0.078	91	7.66	<0.001
Chronological Age	0.168	0.052	51	3.21	0.002
NVDQ	0.099	0.041	53	2.42	0.019
RJA	0.051	0.027	53	1.86	0.068
RJA*Time	−0.004	0.003	90	− 1.36	0.177
Object Imitation	0.036	0.031	52	1.15	0.254
Object Imitation*Time	0. 0	0.004	91	− 0.06	0.950

Note. NVDQ = nonverbal developmental quotient; RJA = response to joint attention.