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BRIEF REPORT

Brief Report: Parents' Declarative Use of Deictic Gestures Predict Vocabulary Development in Infants at High and Low Risk for Autism Spectrum Disorder

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Abstract
We examined the communicative intentions behind parents' deictic gesture use with high-risk infants later diagnosed with autism spectrum disorder (ASD; $n = 17$), high-risk infants who were not diagnosed with ASD ($n = 25$), and low-risk infants ($n = 28$) at 12 months and assessed the extent to which the parental deictic gesture intentions predicted infants' later vocabulary development. We found that parents in the three groups produced similar numbers of declarative and imperative gestures during a 10-minute parent–child interaction in the lab at 12 months and that 12-month parental declarative gesture use was significantly, positively associated with children's 36-month vocabulary scores. Encouraging parental use of declarative gestures with infants could have important implications for language development.

Keywords Deictic gesture · Intent · Declarative · Imperative · Vocabulary · Autism · Infant siblings

Introduction

Although language deficits and delays are no longer diagnostic criteria for autism spectrum disorder (ASD), they are common among children with ASD (Lazenby et al., 2016; Tager-Flusberg et al., 2005) as well as younger siblings of children with ASD, who are at high familial risk for ASD themselves (hereafter referred to as "high-risk infants"; see Garrido et al., 2017 for meta-analysis). By studying the linguistic environment of high-risk infants, we can identify early risk factors for atypical language development in ASD. Specifically, given the important role parents play in shaping their children's language development (see Bottema-Beutel & Kim, 2020; Swanson, 2020 for reviews), examinations of parent–child interactions are of particular interest.

Findings on the interactional styles of parents of high-risk infants and low-risk infants (i.e., no immediate family history of ASD) are mixed. While some studies reported overall more directive interactional styles in high-risk parents (Harker et al., 2016; Steiner et al., 2018; Wan et al., 2012, 2013), others found similar levels of specific behaviors among parents of high- and low-risk infants, such as scaffolding of infant play (Campbell et al., 2015), responsiveness to infant communication (Choi et al., 2020; Leezenbaum et al., 2014; Talbott et al., 2016), vocal coordination (Northrup & Iverson, 2015), and gestures (Talbott et al., 2015). Regarding parents' *intentions* behind their communication, Talbott et al. (2016) found no robust differences in the categories of maternal speech across high- and low-risk groups when infants were 9 months of age. However, it has not been examined if parents of high- and low-risk infants differ on the communicative intentions behind their *gestures,* nonverbal input that is strongly associated with language development of children (Goldin-Meadow & Butcher, 2003; LeBarton & Iverson, 2017). Specifically, although three studies have reported that high-risk infants and low-risk infants show significant group differences in *imperative* gestures that serve a requesting function and *declarative* gestures that serve a joint attention function (Cassel et al., 2007; Rozga et al., 2011; Yirmiya et al., 2006), no study has compared

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gesture intentions of *parents* of high-risk infants and those of low-risk infants. Of note, different terms have been used in the literature to refer to the communicative intentions of gestures (see review by Manwaring et al., 2018). While the three studies cited here used terms such as Initiating Joint Attention (IJA) and Initiating Behavioral Regulation (IBR) to categorize the functions of infants' gestures observed during the Early Social Communication Scales (ESCS; Mundy et al., 2003), we refer to them as 'declarative' and 'imperative,' respectively, because these terms are commonly used across clinical and non-clinical populations.

Previous work suggests that parents produce gestures with a variety of intentions when interacting with their typically-developing children (Pan et al., 1996; Rowe, 2000; Salo et al., 2019). Parents use gestures declaratively to share attention or interest with their infants. Parents also use gestures imperatively to elicit or control the actions of infants. Importantly, recent evidence suggests that these varying intentions of parental gestures may be differentially related to the vocabulary development of children. For example, Salo et al. (2019) found that parents' use of *declarative* pointing was significantly, positively associated with children's concurrent vocabulary scores at 12 months. By contrast, parents' *imperative* pointing was not associated with children's concurrent vocabulary scores. While these results have been found with parents and their typically-developing children, the question of whether the association between parents' gesture intentions and children's vocabulary skills is similar in dyads of parents and high-risk infants remains unanswered.

Taken together, previous research suggests that an examination of gesture intentions is warranted in parents of high- and low-risk infants. Moreover, it is important to assess whether the association between parents' declarative, but not imperative, gestures and children's vocabulary scores in typical development is similar in high-risk infants, who have an increased risk for language difficulties. Elucidating further aspects of the linguistic environment that support language learning could have implications for the development and implementation of targeted language interventions for children. Our previous work reported a detailed comparison of parent gesture use and a significant, positive relation between the total number of parental gestures at 12 months and the child's vocabulary outcomes at 36 months in high- and low-risk groups (Choi et al., 2021). Building on the previous study, the current study focused on the examination of communicative intentions behind parents' *deictic* gestures (e.g., pointing, showing, giving), in particular, as the meanings of deictic gestures can vary across contexts (Manwaring et al., 2018; Salo et al., 2019). This work aims to (1) examine deictic gesture intentions in parents of high-risk infants later diagnosed with ASD (HRA+), high-risk infants who were not diagnosed with ASD (HRA−), and low-risk comparison (LRC) infants at 12 months and (2) assess whether expressing declarative versus imperative intentions via deictic gestures differentially predicts child vocabulary scores at 36 months.

Methods

Participants

Participants consisted of parent–child dyads ($n = 70$) where infants were classified as high or low familial risk for ASD. High-risk infants ($n = 42$) had an older sibling whose ASD community diagnosis was confirmed by the Social Communication Questionnaire (SCQ; Rutter et al., 2003) and/or the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000). Low-risk infants ($n = 28$) had a typically-developing older sibling and no first- or second-degree relatives with an ASD diagnosis. Of the high-risk infants, 17 later received an ASD diagnosis (HRA+; see the section 'ASD Outcome Classification' for further details), while 25 did not (HRA-). Of the 28 low-risk infants in this study, none received an ASD diagnosis. Mean chronological age of the infants was 12.4 months (SD = 0.4; Range = 10.9–13.6).

Demographic information for the HRA+, HRA−, and LRC groups is provided in Table 1. As can be seen in Table 1, the groups were well-matched in infants' sex and race and household income. However, levels of parental education were significantly different across the three groups ($\chi^2 = 9.75$, $p = 0.008$). Post-hoc pairwise comparisons revealed HRA+ parents had significantly lower education levels, compared to the LRC group ($z = -3.35$, $p = 0.001$). Therefore, in our analyses for research aim 2, we controlled for parental education in regression models predicting infants' vocabulary scores. All infants had a minimum gestational age of 36 weeks, had no known genetic or neurologic disorders, and heard English in the home > 75% of the time.

Procedure and Measures

Data were drawn from the Infant Sibling Project, which was approved by the IRB at Boston Children's Hospital/Harvard Medical School and Boston University. Parents' written informed consent was obtained prior to participation in the study. Supplementary Table S1 provides a summary of the measures collected or coded (described below) at different ages in the present study.

Coding Parent Deictic Gesture Intentions

At the infants' 12-month in-lab study visit, parents ($n_{\text{mothers}} = 67$, $n_{\text{fathers}} = 3$) were asked to play with their child as they normally would during a 10-minute free play

Table 1 Participant characteristics for the three groups

	HRA+	HRA−	LRC	*p* value
Infant participants				
Sex (% male)	71%	36%	50%	.098 ~
Race (% white)	82%	92%	86%	.668
12-month MSEL verbal developmental quotients	87.84 (18.31) 62.5–126.92	98.56 (13.20) 75–129.17	99.11 (12.74) 70.83–118.18	.028*
12-month MSEL receptive language T scores	39.47 (7.91) 25–51	46.00 (6.90) 28–55	46.75 (7.11) 31–60	.004**
12-month MSEL expressive language T scores	45.18 (11.90) 30–73	47.96 (8.43) 33–71	48.39 (7.84) 33–62	.496
36-month MB-CDI vocabulary scores	47.11 (29.82) 12–100	63.64 (22.34) 32–92	73.05 (21.09) 19–94	.059 ~
Parent participants				
Household income[a]	6.53 (2.42) 2–8	7.52 (1.20) 4–8	7.68 (1.09) 3–8	.224
Education[b]	4.93 (1.58) 1–8	5.61 (1.73) 2–8	6.46 (0.98) 5–9	.008**
12-month word types	135.54 (54.31) 57.10–235.23	171.04 (71.95) 75.18–403.28	154.77 (50.08) 89.07–245.23	.235

[a]Household income was reported on an eight-point scale: (1) less than $15,000, (2) $15,000–$25,000, (3) $25,000$35,000, (4) $35,000–$45,000, (5) $45,000–$55,000, (6) $55,000–$65,000, (7) $65,000–$75,000, (8) more than $75,000

[b]Parent education was reported as the highest level attained on a nine-point scale: (1) some high school, (2) high school graduate, (3) some college, (4) community college/two-year degree, (5) four-year college degree, (6) some graduate school, (7) master's degree, (8) doctoral degree, (9) professional degree

~$p < .1$ *$p < .05$, ** $p < .01$

interaction using a standard, age-appropriate set of toys. Parent–child dyads were videotaped and coded for parent gestures (see Choi et al., 2021, for details on the gesture coding scheme). For the present study, parental deictic gestures were further coded at the level of communicative intention: declarative and imperative (Bates et al., 1975; Liszkowski et al., 2004, 2006; Tomasello et al., 2007). Definitions and examples of declarative and imperative gestures can be found in Table 2. As informed by previous work (Salo et al., 2019), contextual cues such as the form and referent of the gesture, language associated with the gesture, and the partner's response were used to help distinguish declarative and imperative gestures of parents. In the current study, the first author developed the coding scheme based on prior research and trained two coders who were blind to group membership. Coding reliability was established by having the first author and the two coders compare and discuss their codes on the same video. Once the coders achieved above 80% agreement on the codes as the first author, two coders independently coded the videos and overlapped 20% of the randomly chosen videos to calculate interrater reliability. The inter-rater reliability was 99.7% ($k = 0.99$, $n = 308$).

Table 2 Definitions and examples of coding parental deictic gesture intentions

Intention of parental gesture	Definition	Examples
Declarative	Gesture is used to share or discuss a joint focus of attention	Parent points to a picture in a book, saying, "The monkey is stealing the key from the zookeeper!" Parent shows a triangle, saying, "This one is pink"
Imperative	Gesture is used to direct or elicit a specific action from the child	Parent uses a palm-up gesture (i.e., a hand rotated to an upward position), saying, "Give it to me!" Parent points to a shape sorter, saying, "Put it in there"

Infant Vocabulary Skills

In the present study, infants' expressive vocabulary scores were measured at 36 months using the MacArthur-Bates Communicative Development Inventory (MB-CDI-III; Fenson et al., 1994), a parent-report measure widely used in research (Frank et al., 2017). Parents were asked to mark the words that they have heard their child say using a 100-item vocabulary checklist, with scores ranging from 1 to 100 words. Descriptive statistics on the sample's 36-month vocabulary outcomes are provided for the three groups in Table 1.

Covariates

Given that research has found that child sex, child prior language skills, and parental speech are related to children's vocabulary development (e.g., Hoff, 2003; Huttenlocher et al., 1991; Rowe, 2008), we considered these variables as potential covariates in our data analyses (in addition to parental education, which differed across the groups). Information on infant sex was obtained from demographic questionnaires. As an index of children's prior language skills, we used children's 12-month Verbal Developmental Quotients from the Mullen Scales of Early Learning (MSEL; Mullen, 1995), a standardized assessment that measures cognitive development across five domains: gross and fine motor, expressive and receptive language, and visual reception. The Verbal Developmental Quotients were calculated by dividing the average age-equivalent scores from the MSEL expressive and receptive language subscales by the chronological age and multiplying by 100. Finally, as an index of parental speech, we used parents' word types (i.e., number of different words that parents spoke during the parent–child interactions automatically calculated using the FREQ command in Computerized Language ANalysis [CLAN; MacWhinney, 2000]) at 12 months. Descriptive statistics on the sample's relevant scores for the covariates are provided for the three groups in Table 1.

ASD Outcome Classification

The Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) was administered at 18, 24, and 36 months by research staff with extensive experience in testing children with developmental disorders and then co-scored by an ADOS-reliable researcher. If infants met criteria for ASD or received a score within three points of the ADOS' ASD cut-off score, a licensed clinical psychologist reviewed videos of the behavioral assessments, including the ADOS, to make a clinical judgment estimate of ASD, no ASD, or other (e.g., ADHD, anxiety) using DSM-5 criteria. Infants classified as 'other' were excluded from the current study.

Data Analyses

To address our first research aim of comparing the three groups on parents' deictic gesture intentions, we used ANOVA or nonparametric tests (Kruskal–Wallis H tests and Mann–Whitney U tests) based on the distributions of data. We examined both raw numbers and the proportion of declarative and imperative gestures. Because the proportion of declarative gestures (e.g., x) is complementary to the proportion of imperative gestures (e.g., 1−x), we examined the proportion of declarative gestures only. The proportion was calculated for each parent by dividing the total number of declarative gestures by total deictic gestures and then averaging across parents in each group. To address our second research aim of assessing whether parents' declarative or imperative gestures differentially predicted child vocabulary scores at 36 months, we first examined partial correlations between parental gesture intentions at 12 months and child vocabulary at 36 months, controlling for parent education, which significantly differed across the groups, and then followed up the results of the correlation analyses with multiple regression analyses while controlling for variables known to predict child vocabulary development (i.e., child's sex, child's prior language skills, and parent's speech).

Results

Descriptive statistics on the communicative intentions of parent deictic gestures are presented in Table 3. There were no significant group differences in the raw numbers of gestures that served a declarative or imperative purpose across HRA+, HRA−, and LRC groups. On average, parents across the groups produced 14 declarative gestures and 13 imperative gestures during the 10-minute interaction with their infant. When examining the proportion of declarative gestures, we found significant differences across the three groups ($F_{2,67} = 4.18$, $p = 0.019$). Bonferroni post-hoc pairwise tests indicated that the HRA + parents used a significantly higher proportion of declarative gestures than the LRC parents ($p = 0.036$).

To address our second research aim, we first examined if the variation in parents' deictic gesture intentions at 12 months correlated with infant vocabulary development at 36 months. Partial correlations controlling for parent education (which significantly differed across the groups) are presented in Table 4. For the entire sample, the number of parental declarative gestures was significantly and positively associated with infants' MB-CDI vocabulary scores at 36 months, after controlling for parent education ($r = 0.37$, $p = 0.030$). The number of parental imperative gestures was positively, but not significantly, correlated with infants' 36-month vocabulary scores. Also, the proportional

Table 3 Descriptive statistics (mean, SD, range) on parental gesture intentions at 12 months

	HRA+ ($N=17$)	HRA− ($N=25$)	LRC ($N=28$)	p value
Number of declarative gestures	14.86 (10.03) 2.33–35.36	15.69 (8.90) 2.06–31.58	11.09 (8.83) 1.05–35.67	.101
Number of imperative gestures	10.10 (6.11) 1.04–24.19	13.58 (8.68) 0.00–36.03	13.69 (5.82) 1.93–23.40	.204
Proportion of declarative gestures	0.58 (0.14) 0.31–0.77	0.53 (0.22) 0.18–1.00	0.42 (0.19) 0.05–0.77	.019*

Note Because the proportion of declarative gestures (e.g., x) is complementary to the proportion of imperative gestures (e.g., 1−x), we report the p-value for one of the proportional measures only. The distribution of the number of declarative gestures was non-normal based on its histogram and Shapiro–Wilk test ($p<.001$); therefore, a non-parametric Kruskal–Wallis H test was used to test group differences. The number of imperative gestures and the proportion of declarative gestures were normally distributed based on respective histograms and Shapiro–Wilk tests; therefore, ANOVAs were used to test group differences

*$p<.05$

Table 4 Partial correlations between parental gesture intentions at 12 months and child vocabulary at 36 months, controlling for parent education, for the entire sample and each group

	Entire Sample	HRA+	HRA−	LRC
Parent declarative gesture				
Number	.37*	.68	.61~	.11
Proportion	.15	.00	.38	−.06
Parent imperative gesture				
Number	.27	.67	.14	.23

~$p<.1$, * $p<.05$

measure was not significantly correlated with the children's vocabulary scores. Within each group, none of the correlations reached statistical significance, presumably due to the reduced sample sizes.

Next, we fit regression models for the whole sample to determine if parents' declarative gesture use at 12 months predicted children's vocabulary outcomes at 36 months, even when adjusting for the potential covariates described above (Table 5). Model 1 shows that parents' declarative gesture use was a significant, positive predictor of children's MB-CDI vocabulary scores after controlling for parent education. Model 2 shows that the effects of declarative gestures remained significant after including the additional covariates (i.e., child's sex, child's 12-month Verbal Developmental Quotients, and parent's 12-month speech) and that none of the covariates were significantly associated with vocabulary outcomes. Finally, in Model 3 we assessed whether the relation between parent's declarative gestures and child's vocabulary outcomes differed by group by examining the interaction between group and declarative gestures. There was a significant effect of the overall interaction ($F_{2,25}=3.70$, $p=0.039$), indicating that the regression lines from the three groups differed significantly. Unadjusted pairwise comparisons showed a significant difference between the HRA+ and LRC groups ($t=-2.45$, $p=0.022$); however, when this result was adjusted for multiple comparisons using Bonferroni correction, it no longer reached statistical significance ($t=-2.45$, $p=0.065$). The scatter plot of parental declarative gestures with child vocabulary scores is displayed in Fig. 1.

Table 5 Regression models predicting children's vocabulary scores at 36 months

	Model 1	Model 2	Model 3
Intercept	27.02 (19.65)	53.57 (32.25)	52.09 (29.40)~
Parent declarative gestures	0.91 (0.40)*	1.11 (0.43)*	3.11 (1.08)**
Parent education	4.58 (2.88)	5.21 (2.93)~	2.20 (2.99)
Child verbal developmental quotients		− 0.33 (0.28)	− 0.43 (0.26)
Child sex		15.38 (7.77)~	10.97 (7.68)
Parent word types		− 0.05 (0.07)	− 0.07 (0.07)
HRA-			22.54 (21.03)
LRC			50.10 (16.63)**
Declarative gesture X HRA-			− 1.49 (1.40)
Declarative gesture X LRC			− 2.84 (1.16)*
R^2(%)	16.9	27.7	49.1

~$p<.1$, * $p<.05$, ** $p<.01$

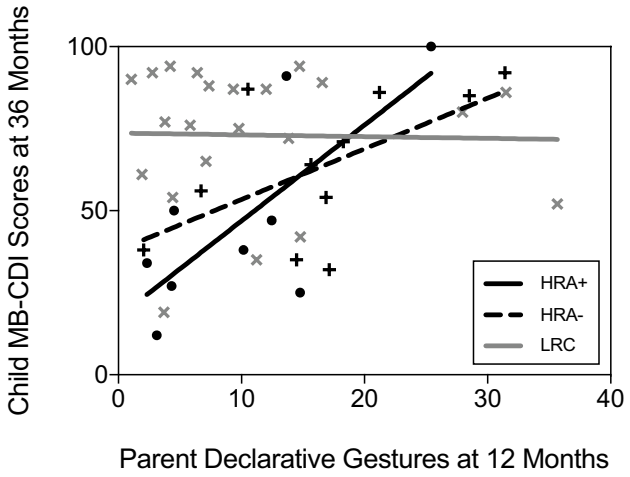

Fig. 1 Scatterplot (with Best-Fit Lines) Showing the Relation between Parent's Declarative Gesture Use at 12 Months and Child's Vocabulary Outcome at 36 Months. *Note.* Black line and circles represent data for high-risk infant later diagnosed with ASD (HRA+). Black dashed line and plus signs represent data for high-risk infant not diagnosed with ASD (HRA−). Gray line and Xs represent data for low-risk comparison infants (LRC)

Discussion

The current study examined the communicative intentions behind parental deictic gesture use with HRA+, HRA−, and LRC infants at 12 months and assessed the extent to which the parental gesture intentions at 12 months predicted children's vocabulary scores at 36 months. Our main findings were that parents produced similar numbers of declarative and imperative gestures at 12 months regardless of their infant's ASD risk and eventual diagnosis, and that across all groups, 12-month parental declarative gesture use was a significant, positive predictor of children's 36-month vocabulary scores.

Several studies found that parents of children with or at risk for ASD used more directive interactional styles (Harker et al., 2016; Steiner et al., 2018; Wan et al., 2012, 2013). In the gestural realm, this was not the case in our sample, as parents of HRA+, HRA−, and LRC infants produced comparable numbers of declarative and imperative gestures at 12 months. Moreover, when examining the proportion of the intention types, controlling for the quantity of deictic gestures, the proportion of declarative gestures was significantly higher in HRA+ parents than LRC parents. Thus, these results suggest that parents who have a child with ASD provide gestural input of similar quality, if not use more declarative gestures, than parents who have a typically-developing child.

The mixed findings on the parental interactional styles could be attributed to several non-mutually exclusive factors. First, they may be due to differences in the metrics used to examine parental behaviors. For instance, Wan et al. (2012, 2013) and Harker et al. (2016) used *expert rating scales* in which coders recorded global judgments about the parent–child interactions and found higher directiveness among parents of high-risk infants than parents of low-risk infants. By contrast, we used frequency and proportion measures to compare parental declarative and imperative gestures and found no group differences in the number of gesture intentions and a higher proportion of declarative gestures in parents of high-risk infants later diagnosed with ASD. While the method of *count coding* used in the present study captures individual variation in the construct of interest better than rating scales, which are limited by the range of possible scores, different approaches to systematic observation have their own strengths and limitations (Yoder et al., 2018). In sum, given the differences in measurement, future research should consider using different metrics on the same data to evaluate the impact of metric choice (Harbison et al., 2017).

The inconsistent patterns of the findings may also be attributed to potential differences in the samples. In our sample, infants across all groups scored within one standard deviation of the population mean on both expressive and receptive language subscales of the Mullen Scales of Early Learning at 12 months (Table 1), indicating that at this age, the infants achieved language scores within the range of typical development regardless of their ASD risk and eventual outcome. Therefore, our infants (and how they interact with their parents and vice versa) might not be representative of the larger population. Also, levels of parental education were high across all groups, with 87% of our parent sample having a 4-year college degree or beyond. While some previous studies also report high levels of parental education (Harker et al., 2016; Steiner et al., 2018), others do not provide directly comparable information (e.g., only parents' occupation status is provided in Wan et al., 2012, 2013), making it unclear if our sample characteristics are indeed different from others. In future research, it will be useful to obtain a large and diverse group of parents and their high- and low-risk infants and provide detailed participant information to fully understand similarities and differences in the interactional styles among parents of high- and low-risk infants.

In our previous work, we found that the quantity of parent gestures at 12 months predicted parental report of the child's vocabulary scores at 36 months in HRA+, HRA−, and LRC groups (Choi et al., 2021). Building on the previous study, we found that 12-month parents' *declarative* gestures, in particular, were significantly positively associated with children's vocabulary scores at 36 months. This association held after controlling for parent education, child sex, child 12-month Verbal Developmental Quotients, and parent 12-month speech, and it was present regardless of the infant's risk for ASD and eventual diagnosis. Thus, children

of parents who use more declarative gestures at 12 months have a larger vocabulary size two years later. Nevertheless, it is worth noting that we measured children's vocabulary using a parent questionnaire rather than an independent objective measure. Given the potential bias in parent reports, future work should use other (and ideally, multiple) sources of information on language, such as natural language samples and standardized assessments (Barokova & Tager-Flusberg, 2020) to further examine the role of parental deictic gesture intentions on infant vocabulary development.

One explanation for the association between parents' declarative gestures and children's vocabulary development is that declarative gestures, which are intended to achieve a social goal of sharing interest or information with a partner, may lead to more opportunities for joint attention that is known to be beneficial for language learning (Mundy et al., 2007; Tomasello & Farrar, 1986). Salo et al. (2018), for example, found that declarative points, but not imperative points, were related to joint attention measured on the Early Social Communication Scales (Mundy et al., 2003). Relatedly, studies found that parents talked and responded more during joint attentional activities than other interactional contexts (Gros-Louis et al., 2016; Sosa, 2016). Also, it is possible that parents provide the label of referent of their declarative gesture, which may facilitate the development of children's vocabulary (Dimitrova et al., 2016; Goldin-Meadow et al., 2007). Taken together, these findings suggest that parental declarative gestures could lead to more episodes of joint attention that elicit more parental input and reciprocal communication with infants.

Additionally, parental declarative gestures could play an indirect role in language learning by encouraging *infants'* own use of declarative gestures. Camaioni (1997) posited that children's use of declarative gestures reflects their understanding of others as intentional agents. Therefore, a child who understands that s/he can affect another person's attentional state may produce more declarative gestures (e.g., showing a ball) and receive timely input from parents (e.g., "You found a ball!") than the child who does not have this understanding. In fact, meta-analyses have revealed a robust relation between *children's* declarative gestures and language skills in typical development as well as ASD (Colonnesi et al., 2010; Harbison et al., 2017), providing some support to this explanation.

By implication, these findings suggest that parents' use of declarative gestures may especially be helpful in promoting vocabulary development of children, including those who are at high risk for ASD and those who develop ASD. Our previous study reported that the quantity of parental gestures predicted children's vocabulary development (Choi et al., 2021), and here, our results further reveal that parents' *declarative* gestures may be a particularly powerful factor associated with children's vocabulary development. Thus, interventionists and parents should consider prioritizing the use of declarative gestures with children at risk for or with ASD, who often exhibit language delays or deficits (Anderson et al., 2007; Tager-Flusberg & Kasari, 2013). In addition, given that these findings were correlational in nature, there is a need for research to examine whether parents' use of declarative gestures play a causal role in vocabulary development of children by manipulating the communicative intentions of parental gestures.

In conclusion, the present study builds on the previous literature by examining the intentions behind parent deictic gestures by identifying the association between parents' declarative gestures and vocabulary development in ASD high- and low-risk infants. However, given the correlational nature of the data and limited sample size in the present study, further research is needed to shed light on the mechanisms underpinning this relation. If replicated in future research, these findings will have implications for creating more targeted and effective language interventions for children.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10803-021-04989-8.

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Author Contributions BC was involved in study conception and coding, analyzed and interpreted the data, and drafted the manuscript. LC and RM contributed to data coding and reliability and provided intellectual contributions throughout the project. MLR critically revised the manuscript for intellectual content. CAN and HTF were the co-principal investigators of the Infant Sibling Project and critically revised the manuscript for intellectual content. All authors read and approved the final manuscript.

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Declarations

Conflict of interest The authors declare that they have no conflict of interests.

Ethical Approval All procedures performed in the current study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consents Informed consent was obtained from all individual participants included in the study.

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