

# Prelinguistic gesture use in mother-infant and mother-infant-sibling interactions

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I tested the hypothesis that, in infant-mother-sibling interactions, infants with older siblings aged 11 to 24 months produce deictic gestures when they are proximal to, or engaging in joint attention with, their mothers more frequently than same-aged infants without siblings. Fifteen infant-mother dyads and 10 infant-mother-sibling triads were individually observed for 15 minutes in a playroom full of toys. Infants involved in infant-mother-sibling interactions produced more deictic gestures when they were proximal to their mothers than infants in infant-mother interactions. Further, infants involved in infant-mother-sibling interactions accompanied their gestures with vocalizations at a higher rate than infants in infant-mother interactions. This result suggests that infants with older siblings monitor their mothers more carefully in interactions in which their sibling is also present, and that they produce deictic gestures in order to effectively elicit joint action with their mothers.

**Keywords:** infants, deictic gestures, siblings, mother-infant-sibling triads, joint attention, physical proximity

## 1. Introduction

Although infants in their second year of life cannot use language adequately, they can communicate with adult caregivers using deictic gestures, such as pointing or showing gestures (Butterworth, 2003; Goldin-Meadow, Goodrich, Sauer, & Iverson, 2007). First gestures, which usually consist of pointing to indicate objects in the environment, start between the ages of 8 and 15 months (Butterworth, 2003; Franco, 2005; Liszkowski & Tomasello, 2011).

Interestingly, infants' deictic gestures emerge before their language acquisition, irrespective of culture. Liszkowski, Brown, Callaghan, Takada, and de Vos (2012) used a standardized, semi-naturalistic gesture-elicitation procedure called

“decorated room” in seven cultures including Papua New Guinea, Indonesia, Japan, Peru, two regions of Mexico, and Canada to investigate empirically whether preverbal infants and their caregivers produce index-finger pointing. Results showed that infants aged 10 to 14 months and their caregivers in all cultures produced index-finger pointing with similar frequency. Thus, they suggested the existence of a gestural universal in human communication that forms the basis of prelinguistic interactions.

It has also been demonstrated that infants’ social environment affect the emergence of their deictic gestures. Salomo and Liszkowski (2013) conducted natural observations of 8- to 15-month olds and their interlocutors in three different cultures, namely Yucatec-Mayans (Mexico), Dutch (Netherlands), and Shanghai-Chinese (China). They found that the frequency of deictic gestures by infants in China was the largest among these three cultures, and that the fewest gestures occurred in the Mexican sample. The amount of joint action – the approximate duration of infant-interlocutor engagement about an external entity or event – was similar. The amount of joint action between infants and their interlocutors in China was the largest among these three cultures, and that in Mexico was the smallest. Furthermore, after controlling for both infant age and cultural differences, it was revealed that the more the infants engaged in joint action with interlocutors, the more frequently infants produced deictic gestures. These results suggest that the emergence of prelinguistic deictic gestures is socially mediated, that is, the behaviors by the interlocutors around the infants impact the formation of deictic gestures by the infants (Salomo & Liszkowski, 2013).

Although the cross cultural study mentioned above (Salomo & Liszkowski, 2013) revealed positive correlations between the frequency of deictic gestures by preverbal infants and the amount of joint action between the infants and their interlocutors, it remains unknown as to how the production of deictic gestures by infants depends the opportunity to engage in joint action with adult interlocutors. The long-term effects of growing environment on the production of deictic gestures by infants must be grounded to the results of the infants’ coping with their social environment. Thus, it is necessary to observe how infants produce their deictic gestures in response to their social environment.

One prediction is that infants who have more opportunities to engage in joint action with adult interlocutors produce deictic gestures relatively frequently because the interlocutors often attend to the infants, and thus notice and respond to the gestures made by them. In contrast, infants with few opportunities to engage in joint action with adult interlocutors decline to produce deictic gestures because the interlocutors seldom attend to the infant, and may respond inappropriately to the gestures. Thus, infants in such a context would produce their deictic gestures carefully, when the adults are noticeable to their gestures in order to engage in

joint action more effectively. The empirical evidence supports this hypothesis. For Example, 12- and 18-month-old infants produced pointing gestures less frequently in an experimental condition in which the adult experimenter never looked at the infant when the stimulus behind the experimenter was activated, in comparison to infants toward whom the experimenter was attentive (Liszkowski, Albrecht, Carpenter, & Tomasello, 2008). Additionally, in other experiments, infants aged 12 months continued to produce pointing gestures if the adult experimenter repeatedly looked back and forth between the infant and the infant's target, and pointed and commented positively about it, signifying that the experimenter was participating in the event with the infant. In contrast, infants declined to produce pointing gestures if the adult experimenter only looked at the infant's hands, neglected to observe the event and the infant's face, and never talked positively about the event (Liszkowski, Carpenter, Henning, Striano, & Tomasello, 2004). These studies suggest that when producing deictic gestures, infants attempt to avoid neglect by their interlocutors.

Another prediction is that infants with less opportunity to engage in joint action with interlocutors accompany their deictic gestures with vocalizations at a higher rate than those with more opportunity to engage in joint action with adult interlocutors. Infants often accompany deictic gestures with vocalizations such as "ah" or "da" (Butterworth, 2003; Liszkowski et al., 2008). Even when adult interlocutors are not currently attending to the gesturing infant, if the infant vocalizes it could attract the interlocutor's attention to the gesture (Liszkowski et al., 2008).

While some experimental studies have supported this idea, others have not. For example, Legerstee and Barillas (2003) revealed that more 12-month-old infants accompanied pointing gestures with vocalizations when the adult interlocutors looked at a different stimulus than the infant, compared with when the adult interlocutors looked at the same stimulus. This suggests that the infants attracted the adults' attention by combining vocalizations with gestures when the adult did not look where the infants pointed. In contrast, Liszkowski et al. (2008) showed that 12- and 18- month- old infants accompanied their pointing gestures with vocalizations regardless of whether the adult interlocutor observed the pointing infant or not. This suggested that infants' vocalizations were not associated with their deictic gestures to attract adults' attention toward the gestures, because infants associated their vocalization at the comparable rate irrespective of whether or not the interlocutor looked at the infants. Therefore, it is unclear whether infants accompany their deictic gestures with vocalizations contingent on interlocutors' availability to engage in joint action.

In this study, I compared the production of deictic gestures by infants without siblings during mother-infant interactions with gestures made by infants with older siblings during triadic interactions (i.e., interactions between a mother, infant,

and sibling). When multiple children are present, the caregiver's attention must be divided among the children under their care (Benigno, Clark, & Farrar, 2007; Jones & Adamson, 1987; Tomasello, Mannle, & Kruger, 1986). Therefore, infants with older siblings may have less of an opportunity to engage in joint action in mother-infant-sibling interactions than those without siblings in mother-infant interactions. I hypothesized that, in mother-infant-sibling interactions, infants with older siblings would adjust their deictic gestures by producing them at the point in time when they could begin to engage in joint action with their mother.

This study considered infants' proximity to, and joint attention with, their mother as the appropriate criteria to start joint action. A mother would easily notice her infant's gesturing if the dyad were already engaged in joint attention (Moore & D'Entremont, 2001). Moreover, the physical proximity of infant and mother is likely important in the commencement of joint action. In dyadic interaction, it is necessary for both participants to share a sense of togetherness (Zhao, 2003). Physical proximity is the most primitive mode of human togetherness, and the fundamental requirement for establishing nonverbal communication (Krueger, 2011; Zhao, 2003). Thus, to establish joint action, an infant should produce deictic gestures when close to his or her mother.

In this study, I hypothesized that, in mother-infant-older sibling interactions, infants would produce deictic gestures when already engaging in joint attention with their mother, or when the mother was proximal, as opposed to infant-mother interactions without older siblings. Additionally, I compared how infants accompanied their deictic gestures with vocalizations in these two kinds of social environment.

## 2. Methods

### 2.1 Participants

Twenty-five Japanese infants and their mothers took part in this study. Fifteen of the infants ( $n = 9$  boys and  $n = 6$  girls, mean age = 16.73 months, age range = 11–24 months) had no siblings, while 10 ( $n = 5$  boys and  $n = 5$  girls, mean age = 18.20 months, age range = 11–24 months) had one or two older siblings (nine infants had one older sibling, and one had two siblings). These older siblings ( $n = 4$  boys and  $n = 6$  girls, mean age = 44.90 months, age range = 17–70 months) also participated in the study;<sup>1</sup> if there were two older siblings, the one who was closest in age to the infant participated. All of the participants lived near Tokyo, Japan. The

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1. One of the infants was a twin. Their mother provided their birth order information.

research was approved by the Research Ethics Committee of the Department of Psychology at the University of the Sacred Heart.

## 2.2 Apparatus and data collection

This study took place in a playroom approximately 30 m<sup>2</sup> in size, which contained 12 types of toys (i.e., nesting cups, stacking blocks, shape-matching puzzles, dolls, cars, items for house play, etc.). The room was large enough for the participants to move around and play freely. Each family was allowed to play freely without interruption for 15 minutes, and this play session was recorded with a video camera (Sanyo DMX-CG110-K or Sony HDR-CX560V). During observations, only brief responses were given to participants' inquiries.

## 2.3 Data coding

The infants' deictic gestures were also coded as either *pointing* (i.e., the simultaneous extension of the arm and index finger toward a target) or *showing* (i.e., holding up an object while looking at the mother).<sup>2</sup> When the deictic gestures were coded, I also assessed whether the infants vocalized during the gestures, whether infants and their mothers were *proximal* (i.e., within reach), and whether they were engaging in *joint attention* (i.e., the mother directing her gaze toward her infant, or mother and infant directing their gazes toward the same object, Emery (2000)). Vocalizations that were thought to be a reaction to comments the mother made in response to her infant's deictic gestures were not coded. Deictic gestures made by infants with the older sibling were coded, as was whether the older sibling and mother were proximal.

In conjunction with the coding of the deictic gestures, using 5-second fixed-interval sampling (Martin & Bateson, 1990), whether the mother and infant were proximate and engaging in joint attention was checked at intervals of five seconds. Thus, the mother-child interactions were coded at 180 sample points per 15-minute observation period. The proximity proportion (%) was calculated as the number of sample points for which a mother and her infant were proximal, divided by the total number of sample points (180), and then multiplied by 100.

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2. This study only considered gestures directed by infants with an older sibling toward their mother, because the frequency of gestures toward older siblings was low (mean = 0.9, range = 0–3). However, I coded all pointing gestures made by infants with and without siblings in the 15-minute play session, as it was difficult to confirm the targeted recipient of these pointing gestures by simply observing the behaviors of the infants, such as their gaze alternation (e.g., Liszkowski, Albrecht, Carpenter, & Tomasello, 2008).

The proportion of the time during which an infant and mother engaged in joint attention (%) was calculated as the number of sample points for which infant and mother engaged in joint attention, divided by the total number of sample points (180), multiplied by 100. When coding infants with an older sibling, whether the mother and older sibling were proximate was coded similarly.

In order to assess reliability, the actions of six infants (three with older siblings and three with no siblings) and their mothers were coded by two graduate school students. These codings correlated significantly with the main coding ( $r_s > .89$ ,  $p_s < .05$ ) for the number of deictic gestures, the proximity proportion, the joint attention proportion between infants and their mothers, and the proximity proportion between older siblings and mothers. Cohen's kappa values indicated that intercoder reliability ranged from substantial to excellent (Fleiss, Levin, & Paik, 2003) for whether infants vocalized during deictic gestures (.85), whether infants and their mothers were proximate (.81), or engaging in joint attention (.79), and whether older siblings and mothers were proximate when the infants made deictic gestures (1.00).

## 2.4 Data analysis

Analysis of the current study's data was modeled on Yamada (2008), who investigated whether the behaviors of Japanese macaque infants occurred at random or in association with the behaviors of their mothers, by calculating the *expected frequency* of the behaviors.

If an infant produced deictic gestures independently of whether or not his or her mother was within reach, the expected frequency of the infants' deictic gestures produced when their mothers were proximal was the values that the total number of deictic gestures was prorated by the proportion of the time the infant and mother were proximal. That is, the expected frequency was the number of deictic gestures multiplied by the proximity proportion, divided by 100. Similarly, the expected frequency of deictic gestures made by an infant when he or she was engaged in joint attention with his or her mother was calculated by multiplying the number of deictic gestures by the proportion of the time during which mother and infant were engaged in joint attention, divided by 100. The expected frequency of an infant's deictic gestures with vocalization produced when his or her mother was proximal or engaged in joint attention were calculated by multiplying the number of deictic gestures including vocalization by the proximity proportions or the proportion of the time during which mother and infant were engaged in joint attention, respectively, divided by 100. Finally, for mother-infant-older sibling interactions, the expected frequency of deictic gestures made by an infant when the mother was proximal to the older sibling was calculated by multiplying the

number of deictic gestures by the proportion of the time during which the mother and older sibling were proximal, divided by 100.

If an infant tended to produce deictic gestures when proximal to his or her mother, the *observed frequency* of those gestures would be higher than the expected frequency. Thus, the *observed/expected frequency ratio* was used to assess whether infants tended to produce deictic gestures when proximal to their mothers. A ratio of greater than unity indicated the infant tended to produce deictic gestures when proximal to his or her mother. Conversely, a ratio of less than unity indicated that the infant tended to produce deictic gestures when not proximal to his or her mother. The observed/expected frequency ratios were calculated similarly for the other measures.

To investigate whether the presence of an older sibling altered the frequency of deictic gesture production, the observed/expected frequency ratios were compared between infants with and without siblings.

### 3. Results

#### 3.1 Frequency of deictic gestures produced by infants

The infants with older siblings produced significantly fewer deictic gestures ( $M = 8.60$ ,  $SD = 7.15$ ) than those without siblings ( $M = 18.40$ ,  $SD = 13.50$ ),  $t(23) = 2.10$ ,  $p < .05$ ,  $d = .86$ . To check whether infant age affected the frequency of deictic gestures, correlations were obtained separately for infants with and without siblings. There was a significant positive correlation between the frequency of deictic gestures made by infants without siblings and infant age in months,  $r(14) = .61$ ,  $p < .05$ , but the correlation between the frequency of deictic gestures made by infants with older siblings and infant age in months was not significant,  $r(9) = .37$ , *n.s.* Thus, infants without siblings in mother-infant interactions produced more deictic gestures than infants with older siblings in mother-infant-older sibling interactions. Additionally, the older the infants without siblings, the more deictic gestures they produced in mother-infant interactions. In contrast, there was no relationship between the age of infants with older siblings and the frequency of deictic gestures.

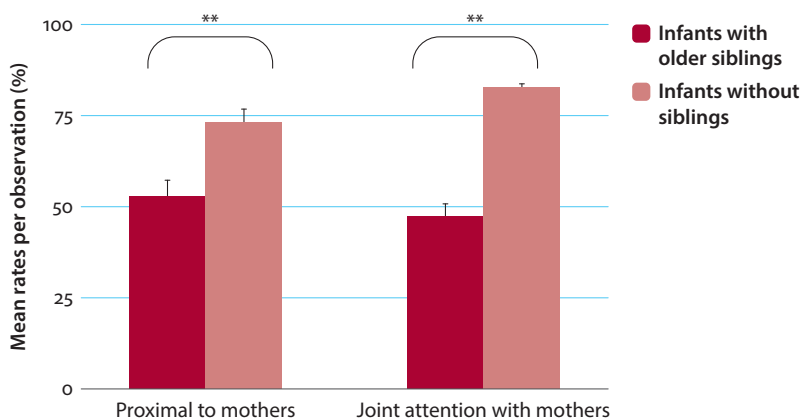
#### 3.2 Deictic gestures with vocalization

The infants with older siblings vocalized during the production of gestures significantly more frequently ( $M = 75.9\%$ ,  $SD = 30.96$ ) than those without siblings ( $M = 42.5\%$ ,  $SD = 26.91$ ),  $t(23) = -2.86$ ,  $p < .01$ ,  $d = 1.17$ . There were significant

positive correlations between the proportion of deictic gestures accompanied by vocalization and age in months for infants with siblings,  $r(9) = .76$ ,  $p < .05$ , and those without siblings,  $r(14) = .56$ ,  $p < .05$ . One infant without an older sibling and two with older siblings never accompanied their deictic gestures with vocalization.

### 3.3 Proximity to mother and joint attention

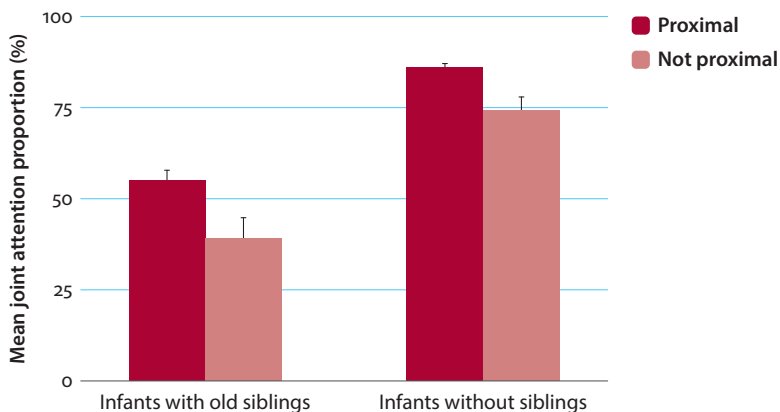
Figure 1 shows the average proximity and joint attention proportions for infants with and without older siblings. Infants without siblings were proximal to their mother more often than those with older siblings,  $t(23) = 3.30$ ,  $p < .01$ ,  $d = 1.40$ . Additionally, infants without siblings engaged in joint attention with their mother significantly more often than those with older siblings (Welch's  $t$ -test:  $t(10.13) = 9.22$ ,  $p < .01$ ,  $d = 4.68$ ).



**Figure 1.** Mean ( $\pm 1$  SE) proximity and joint attention proportions between infants and their mothers. \*\*  $p < .01$ . SE: standard error

Figure 2 shows the average joint attention proportions of infants with and without older siblings when infants were and were not proximal to their mother. A two-way ANOVA was conducted to compare the proportion of the time mothers engaged in joint attention with infants with and without older siblings (between-participant factors) according to whether the infant was proximal to his or her mother or not (within-participant factors). The interaction between the presence of an older sibling and proximity was not significant,  $F(1, 23) = 0.43$ ,  $n.s.$ , but there were significant differences between infants with and without older siblings,  $F(1, 23) = 72.52$ ,  $p < .01$ , and differences contingent on whether the mother was proximal to the infant,  $F(1, 23) = 18.05$ ,  $p < .01$ . Joint attention occurred more frequently when mothers were proximal for both infants with and without older siblings.





**Figure 2.** Mean ( $\pm 1$  SE) joint attention proportions for infants and their mothers when they were and were not proximal to each other. SE: standard error

In summary, both the proportion of the time infants were proximal to mothers, and the proportion of the time infants were engaged in joint attention with mothers, were higher in infants without siblings than those with older siblings. Additionally, infants and their mothers engaged in joint attention more often when they were proximal than when they were not, irrespective of whether or not they had older siblings.

### 3.4 Proximity, joint attention, and the frequency of deictic gestures

To investigate the effects of proximity and joint attention with mothers on the frequency of infant deictic gestures, partial correlations were obtained, after adjusting for infant age and whether or not they had older siblings (dummy-coded; Table 1). There was a positive correlation between the frequency of deictic gestures and proximity,  $r(\text{par}, df = 21) = .57, p < .01$ . There were no significant correlations between any of the other combinations.

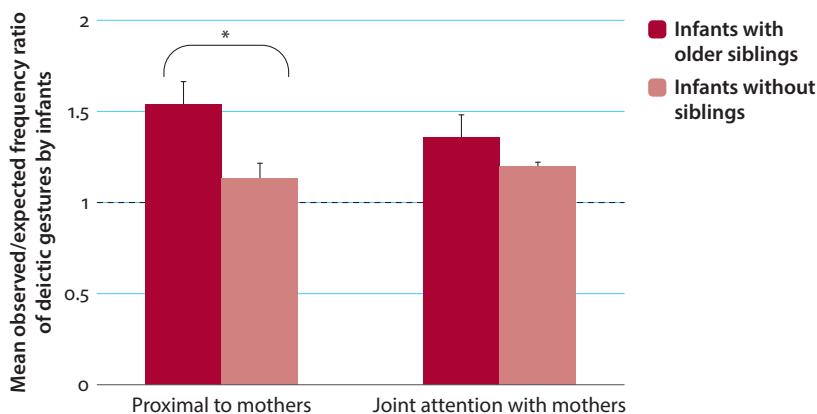
**Table 1.** The coefficient of correlation among the frequency of deictic gestures by infants, the proximity rates between infants and mothers, and the rates at which infants and mothers engaged in joint attention after controlling the age of infants and whether the infants had older siblings

	1.	2.	3.
1. The frequency of deictic gestures by infants	–	.57 <sup>a</sup>	.14
2. The proximity rates between infants and mothers		–	.23
3. The rates at which infants and mothers engaged in joint attention			–

<sup>a</sup>.  $p < .01$

### 3.5 Observed/expected frequency ratios of deictic gestures for infants with and without older siblings

Figure 3 shows the average observed/expected frequency ratio of the deictic gestures of infants with and without older siblings while proximal to, and engaging in joint attention with, their mother. For proximity, the observed/expected frequency ratio of infants with older siblings was significantly higher than that of the infants without siblings,  $t(23) = 2.67, p < .05, d = 1.09$ . The observed/expected frequency ratio for infants with older siblings was significantly greater than unity (one-sample  $t$ -test:  $t(9) = 4.06, p < .01, d = 1.82$ ). In contrast, the observed/expected frequency ratio for infants without siblings was not significantly different from unity (one-sample  $t$ -test:  $t(14) = 1.51, n.s., d = .55$ ). There were no significant correlations between the observed /expected frequency ratio and infant age in months for both infants with,  $r(9) = .20, n.s.$ , and without siblings,  $r(14) = -0.06, n.s.$  Thus, in mother-infant-sibling interactions, infants with older siblings produced deictic gestures when they were proximal to their mothers more often than those without siblings in mother-infant interactions. Infants with older siblings produced deictic gestures more often when they were proximal to their mother, while infants without siblings did not produce deictic gestures according to whether they were proximal to their mother.



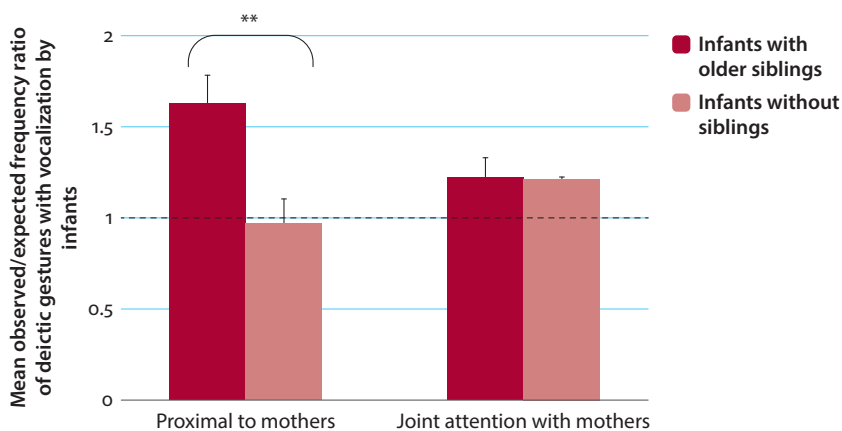
**Figure 3.** Mean ( $\pm 1$  SE) observed/expected frequency ratios of infants' deictic gestures when they were proximal to, or engaging in joint attention with, their mothers. The dashed line represents the observed frequency equal to the expected frequency ratio, indicating that infants produced deictic gestures independently of whether or not they were proximal to their mothers, and whether or not the mothers engaged in joint attention with their infants. \*  $p < .05$ . SE: standard error

When infants and their mothers engaged in joint attention, the observed/expected frequency ratio of deictic gestures made by the infants with older siblings was no

different from that of infants without siblings (Welch's  $t$  test:  $t(9.66) = 1.20$ ,  $n.s.$ ,  $d = .59$ ). The observed/expected frequency ratio for infants with older siblings was significantly greater than unity (one-sample  $t$ -test:  $t(9) = 2.72$ ,  $p < .05$ ,  $d = 1.22$ ), as was the ratio for infants without siblings (one-sample  $t$ -test:  $t(14) = 7.88$ ,  $p < .01$ ,  $d = 2.88$ ). There were no significant correlations between the observed / expected frequency ratio and infant age in months for both infants with siblings,  $r(9) = -0.56$ ,  $n.s.$ , and those without siblings,  $r(14) = -0.08$ ,  $n.s.$  Thus, both infants with and without older siblings produced deictic gestures more often when they were engaged in joint attention with their mother.

### 3.6 Observed/expected frequency ratios of deictic gestures accompanied by vocalization for infants with and without older siblings

Figure 4 shows the average observed/expected frequency ratio of deictic gestures accompanied by vocalization for infants with and without older siblings, while proximal to, and engaging in joint attention, with their mother. The expected frequency of infants who never accompanied their deictic gestures with vocalizations was zero. This renders the observed/expected frequency ratio infinite, because the denominator is zero. Thus, the data of infants who never accompanied their deictic gestures with vocalizations were eliminated ( $n = 2$  infants without siblings, and  $n = 1$  infant with an older sibling).



**Figure 4.** Mean ( $\pm 1$  SE) observed/expected frequency ratios of infants' deictic gestures with vocalization when they were proximal to, or engaging in joint attention with, their mothers. The dashed line represents the observed frequency equal to the expected frequency ratio, indicating that infants produced deictic gestures independently of whether or not they were proximal to their mothers, and whether or not the mothers engaged in joint attention with their infants. \*\*  $p < .01$ . SE: standard error

Regarding proximity, the observed/expected frequency ratio of deictic gestures with vocalization made by infants with older siblings was significantly higher than that of infants without siblings,  $t(20) = 3.12$ ,  $p < .01$ ,  $d = 1.35$ . This ratio for infants with older siblings was significantly greater than unity (one-sample  $t$ -test:  $t(8) = 4.06$ ,  $p < .01$ ,  $d = 1.88$ ). In contrast, the ratio for infants without siblings was not significantly different from unity (one-sample  $t$ -test:  $t(12) = 0.25$ ,  $n.s.$ ,  $d = .10$ ). The ratio was not correlated with infant age in months for both infants with siblings,  $r(8) = -0.25$ ,  $n.s.$ , and those without siblings,  $r(12) = 0.13$ ,  $n.s.$  Thus, infants with older siblings in mother-infant-sibling interaction produced deictic gestures with vocalization when they were proximal to their mothers more often than those without siblings in mother-infant interactions. Infants with older siblings accompanied their deictic gestures with vocalizations more often when they were proximal to their mother than they were not. In contrast, infants without siblings did not vocalize while gesturing according to whether or not they were proximal to their mother.

When infants and their mother engaged in joint attention, the observed/expected frequency ratio of deictic gestures with vocalization made by the infants with older siblings was not significantly higher than that of infants without siblings (Welch's  $t$  test:  $t(8.27) = 0.37$ ,  $n.s.$ ,  $d = .02$ ). The ratio for infants with older siblings was not significantly different from unity (one-sample  $t$ -test:  $t(8) = 1.82$ ,  $n.s.$ ,  $d = .86$ ). The ratio for infants without siblings was significantly greater than unity (one-sample  $t$ -test:  $t(12) = 13.75$ ,  $p < .01$ ,  $d = 5.40$ ). There were no significant correlations between the ratio and infant age in months for both infants with siblings,  $r(8) = -0.43$ ,  $n.s.$ , and those without siblings,  $r(12) = -0.50$ ,  $n.s.$

### 3.7 The effect of proximity and joint attention on observed/expected frequency ratios

If infants produced deictic gestures in coordination with the proximity or engagement in joint attention with their mothers, it was predicted that infants who were proximal to, or engaged in joint attention with their mothers frequently, would yield a relatively small observed/expected frequency ratio of deictic gestures, because the gestures produced would be more readily noticed by the infants' mothers. On the other hand, infants who were infrequently proximal to, or engaged in joint attention with, their mother would generate relatively high observed/expected frequency ratios because their deictic gestures would be less noticeable.

To test this prediction, two partial correlation analyses were conducted, each controlling for infant age and the existence of an older sibling (dummy-coded). The first correlation was between proximity proportions and the observed/expected frequency ratios when the infants were proximal to their mother, and the

second was between the joint attention proportion and the observed/expected frequency ratios when infants were engaged in joint attention with their mother. The results supported the predictions; there was a significant negative correlation between proximity proportions and the observed/expected frequency ratio when infants were proximal to their mother,  $r(\text{par}, df = 21) = -0.43, p < .05$ , and a significant negative correlation between joint attention proportions and the observed/expected frequency ratio when infants were engaged in joint attention with their mother,  $r(\text{par}, df = 21) = -0.58, p < .01$ . Thus, infants who spent less time in proximity to their mother produced deictic gestures more when they were in proximity to their mother. Additionally, infants who spent less time in engaging in joint attention with their mother produced their deictic gestures more when they were engaging in joint attention with their mother.

### 3.8 Additional analyses on infants with older siblings

When infants were proximal to their mothers, the older siblings were similarly proximal 41.43% of the time ( $SD = 29.56$ ). There was a significant negative correlation between the proportion of the time older siblings were proximal to mothers when the infants were also proximal and proportion of the time the infants were engaged in joint attention with their mother,  $r(9) = -0.73, p < .05$ . This negative correlation was significant even after controlling for infant age,  $r(\text{par}, df = 7) = -0.70, p < .05$ .

It is possible that in mother-infant-older sibling interactions, the infant would decline to produce deictic gestures when the sibling and mother were proximal because the mother's attention would be directed toward the infant and nearby sibling. Consequently, the probability of the mother neglecting the gesturing infant would become higher. To investigate this possibility, the observed/expected frequency ratio of deictic gestures produced when the older sibling was proximate to his or her mother was compared with unity. The ratio ( $M = 1.33; SD = 1.61$ ) was not significantly different from unity (one-sample  $t$ -test:  $t(9) = 0.64, n.s., d = .29$ ). The ratio was not correlated with infant age in months,  $r(9) = .53, n.s$ . Therefore, infants with older siblings did not produce their deictic gestures according to whether or not an older sibling was proximal to their mother.

## 4. Discussion

In this study, I compared the production of deictic gestures and the use of vocalization by infants with older siblings in infant-mother-older sibling interactions and by those without siblings in infant-mother interactions. Infants with older

siblings produced deictic gestures less frequently during infant-mother-sibling interactions than infants without older siblings in infant-mother interactions. However, the observed/expected frequency ratios of deictic gestures by infants with older siblings were higher than those without siblings for the conditions of proximity with mothers. Further, infants with older siblings accompanied their deictic gestures with vocalizations at a higher rate than infants without siblings. The association between vocalization and deictic gestures made by infants with older siblings was notably high when these infants were proximal to their mother.

The high observed/expected frequency ratios when mothers were proximal suggests that infants with older siblings produced their gestures when they were close to their mother. Theoretically, physical proximity is the most primitive mode of human togetherness, and the foundation for establishing nonverbal communication (Krueger, 2011; Zhao, 2003). When an infant and mother are proximal, the mother would more readily notice their infant's gestures than when the pair are remote. Additionally, in such context, an infant can initiate communication with his or her mother by accompanying deictic gestures with vocalizations if the mother is not directing her attention toward the infant. Therefore, it is likely that infants with older siblings monitored their mothers more carefully in the infant-mother-sibling interactions and produced their deictic gestures when they were in close proximity, because this increased the likelihood of obtaining a response. This contrasts with the way infants without siblings communicated in infant-mother interactions.

The presence of an older sibling in infant-mother interactions may cause infants to be more cautious in producing deictic gestures. Benigno et al. (2007) demonstrated that mothers engaged in joint attention with infants more than twice as long when there was no older sibling vying for attention. Similarly, the current results show that during infant-mother-sibling interactions, infants with an older sibling are less proximal and less engaged in joint attention than those without siblings (i.e., those who experience dyadic interactions with their mothers). Furthermore, infants with older siblings were less engaged in joint attention with their mothers than those without siblings, even when infant and mother were in close proximity. The basis for this was that older siblings were also close to their mother 44.43% of the time when infants were close to their mother. The analysis of infants with older siblings suggested that when an infant and sibling were both near to their mother, infant and mother engaged less frequently in joint attention. This implies that a mother who has multiple children splits her interactions among her children; thus, the availability of the mother's attention is lower for an infant with siblings as compared with an infant without siblings. Thus, an infant with older siblings may need to monitor his or her mother and carefully select when to produce deictic gestures, in order to elicit a response, thereby lowering the frequency of their gestures.

This idea is supported by the negative correlations between observed/expected frequency ratios of gestures and proximity or joint attention. The less proximal and engaged in joint attention with mothers the infants were, the higher the observed/expected frequency ratio. This suggests that an infant who has less time proximal to his or her mother, or has low engagement in joint attention, produces deictic gestures more frequently when near to the mother, and engaged in joint attention with her. Thus, an infant who has a relatively low chance of eliciting a response from his or her mother, such as one with older siblings, monitors his or her mother and produces deictic gestures within comparatively small windows of opportunity.

Regarding vocalization, older infants tended to accompany their gestures with vocalizations more than younger infants. This was true for infants with and without older siblings. This finding concurs with results of previous studies that experimentally revealed an increase in deictic gestures accompanied by vocalization in infants' second year of life (Liszkowski et al., 2008; Liszkowski et al., 2012).

The reason that infants with older siblings accompanied gestures with vocalization more frequently than those without siblings, and did so particularly when they were close to their mother, might be due to the older siblings. As noted by Liszkowski et al. (2008), infants might combine vocalizations and deictic gestures for two purposes: to elicit an adult's attention if the gesture was not observed, and to emphasize their gestures if they were observed by an adult. In mother-infant-older sibling interactions, even when mother and infant were in close proximity, joint attention occurred relatively infrequently because the mother's attention was split between her two children. Therefore, an infant in a mother-infant-sibling interaction might use vocalizations to gain and maintain the mother's attention. In contrast, in mother-infant interactions, joint attention often occurs. Thus, an infant without siblings might use vocalizations primarily to emphasize gestures, and not to elicit the attention of his or her mother. This might explain why infants without siblings often vocalized when engaged in joint attention with their mothers.

Although there was no practical difference between the observed/expected frequency ratios of deictic gestures accompanied by vocalization with and without siblings when they were engaging in joint attention, we found that only the ratio of infants without siblings was significantly higher than unity. This might be because the variance of the ratio of the infants without siblings was low, in contrast with the relatively large variance of the ratio of infants with siblings. Thus, whether only infants without siblings associate their gestures with vocalization when they are engaging in joint attention with mothers remains to be solved.

The additional analysis of infants with older siblings in mother-infant-older sibling interactions revealed no evidence that infants produced deictic gestures in response to the proximity between mother and sibling. The prediction was that in

mother-infant-older sibling interactions, an infant would decline to produce deictic gestures when their sibling was proximal to the mother, because the mother's attention would be directed toward both infant and sibling, and the probability of the mother neglecting the gesturing infant would become higher. However, the analysis suggested that infants produced their deictic gestures independently of the proximity between older siblings and mothers. Perhaps an infant with older siblings distinguishes whether the mother is available to engage joint action not by the proximity between mother and siblings, but by specific communicative cues conveyed by the mother. Previous studies have demonstrated that infants in their second year of life understand that other's communicative acts can be directed to a third party (Gräfenhain, Behne, Carpenter, & Tomasello, 2009; Thorgrimsson, Fawcett, & Liszkowski, 2015). Thus, the infants with older siblings in the current study might have monitored their mother carefully, checking for sibling-mother communication, and producing their gestures at an appropriate time or in an appropriate manner (e.g., by incorporating vocalization), regardless of sibling-mother proximity.

These results do not mean that infants without siblings cannot produce deictic gestures when they want to be noticed by their mothers. Indeed, when infant and mother were engaged in joint attention, the observed/expected frequency ratio for deictic gestures made by infants without siblings was greater than unity. This suggests that infants without siblings produce deictic gestures more often when they are engaged in joint attention with their mother, as has been demonstrated in previous studies (Moore & D'Entremont, 2001; Liszkowski et al., 2008). Perhaps infants have the capability to produce deictic gestures in timely fashion, regardless of whether they have a sibling. However, social environments that force a caregiver to decrease her attention toward her infant, such as the presence of an older sibling, will naturally affect how infants produce deictic gestures. Infants with few opportunities to engage in joint action with adults would avoid neglect by gesturing only if the likelihood of engaging in joint action with their mother were high. The experiences that lead infants to produce deictic gestures in timely fashion could perhaps originate in differences in the frequency of deictic gestures among cultures.

In conclusion, although infants whose mother was obliged to split her attention among multiple children produced deictic gestures relatively infrequently, the results revealed that infants with older siblings produce deictic gestures more effectively in infant-mother-sibling interactions than infants without siblings in infant-mother interactions. This is the first study to reveal differences in communication style between infants with and without older siblings. This suggests that the family environment influences an infant's manner of eliciting joint action with his or her mother via deictic gestures.



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