Relation of Infants' and Mothers' Pointing to Infants' Word Comprehension and Latency to Find Referents

Sura Ertaş, Sümeyye Koşkulu, Ebru Ger, and Aylin C. Küntay

1. Introduction

Infants start communicating with their own gestures and comprehending others' gestures at very early ages. Especially pointing gestures, which involve the extension of the hand and the index finger toward a specific object, location or action, provide a communicative tool to interact with others early on (Bates et al., 1979). There is evidence that infant and parental pointing predict concurrent and prospective language development (Colonnesi et al., 2010). However, parent and infant point production has not been studied in relation to infants' word comprehension by separately considering whole-hand and index-finger pointing forms. Here we investigated whether parents' and infants' use of whole-hand and index-finger pointing was associated with infants' word comprehension.

Although there are studies showing that infants start to produce pointing as early as 3–4 months of age, the very early pointing gesture does not seem to refer to a joint-attentional context (Masataka, 2003), and does not appear to have clear communicative functions (Colonnesi et al. 2010). As the goal of communicating with others emerges at around 8-10 months, infants start to point at objects by using the open palm, which is called whole-hand pointing (Boundy et al., 2016; Veena & Bellur, 2014). Infants start to use index-finger pointing to point at objects around 10-12 months of age (Behne et al., 2012; Cameron-Faulkner et al., 2015; Ger et al., 2018).

1.1. Role of Point Production in Language Development

Colonnesi et al. (2010) showed that there is a concurrent relation between language development and pointing production in a meta-analysis. This relation was found for both receptive and expressive language. In pioneering work Bates et al. (1979) showed that the frequency of pointing gestures was related to language comprehension at the end of the first year. In addition, Murphy (1978) demonstrated that infants' vocalization was significantly associated with their pointing frequency at both 20 and 24 months old.

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Pointing gesture is not only associated with development of language concurrently but it is also associated with language development prospectively (Colonnesi, 2010; Goldin-Meadow, 2007). Infants' production of pointing gestures strongly predicted expressive vocabulary for both typically developing children and children with autism one year later (Özçalışkan et al., 2015). In addition, Brooks and Meltzoff's (2008) study indicates that infants who pointed in actual observations, but not their pointings reported by mothers, showed significant growth in their later productive vocabulary than infants who did not point. On the other hand, the relation of pointing to receptive language was not always found. Firstly, pointing produced by infants before 12 months did not predict receptive vocabulary measured by Japanese version of The MacArthur Communicative Development Inventory (MCDI) at 12 months (Blake et al., 2003). Similarly, infant pointing at 12 and 15 months was not correlated with Peabody Picture Vocabulary Test (PPVT) scores at 39 months (Colonnesi et al., 2008).

1.2. Role of Mothers' Pointing on Language Development

In the first two years of life, infants mostly spend time with adults, especially their caregivers. As mentioned in the previous section, infants not only produce gestures, but also observe and respond to the gestures produced by their caregivers during their interactions. Researchers also investigated different types of gestures produced by caregivers and their effect on infants' language development.

Research on caregivers' gesture input shows that caregivers modify their gestures according to infants' communicative needs when they interact with infants (Dimitrova & Özçalışkan, 2013). For example, Bekken (1989) compared mothers' gestures during interaction with their 18-month-old infants and with an adult. Results showed that when mothers interact with their infants, they use gestures less frequently than when they interact with an adult. Further, mothers mostly produced simpler gestures such as pointing to address their infants. Likewise, the study of Iverson et al. (1999) found that during mother-child interaction, mothers used simpler gestures, namely pointing but they rarely used more complex gestures such as iconic gestures which provide semantic information about objects or actions. A similar pattern was found in Özçalışkan & Goldin-Meadow's (2005) study. When infants were 14, 18, and 22 months old, mothers used conventional and deictic gestures, in other words pointing gestures, more frequently than iconic gestures.

Caregivers' pointing is associated with infants' pointing. In other words, infants who observed more pointing produced by their parents produce more pointing during the interaction (Liszkowski & Tomasello, 2011; Rowe, 2000; Rowe & Goldin-Meadow, 2009a). Furthermore, caregivers' pointing also predicts infants' later vocabulary development. Iverson and colleagues (1999) found that mothers' production of pointing gestures was significantly correlated with infants' vocabulary size at 16 months but not at 20 months. In addition, mothers'

pointing gesture use at 16 months was positively correlated with both infants' expressive vocabulary size and verbal production at 20 months, but these correlations were not significant. Another study conducted by Pan and colleagues (2005) found that 14-month-old infants,whose parents produced a greater amount of pointing gestures, showed faster vocabulary growth at 36 months.

1.3. Current Study

In summary, by the end of their first year, infants produce pointing gestures in mother-infant interaction. Studies showed that infant and parental pointing predict concurrent and subsequent language development (Colonnesi et al., 2010). However, parent and infant point production have not been studied in relation to infants' word comprehension especially by separately considering whole-hand and index-finger pointing forms. Therefore, the present study investigated whether parents' and infants' early use of whole-hand and index-finger pointing at 14 months was associated with infants' later word comprehension and latency to find referents at 18 months. Our specific research questions were:

1. Are infants' and mothers' use of gestures at an earlier age related to infants' subsequent vocabulary?
2. Are the infants' and mothers' use of gestures at an earlier age related to the infant's subsequent latency to find referents of words?
3. Are the hand shapes of infants' pointing gestures (i.e. hand or index finger pointing) associated with their later language skills?

We hypothesized that both the pointing frequency of mothers and infants at 14 months will be related to infants' word comprehension and latency to find referents at 18 months. We also hypothesized that infants' indexical pointing will be a better predictor of their later language abilities than whole-hand pointing.

2. Method

2.1. Participants

The data for this study come from a larger longitudinal study investigating communication, social, and cognitive development of infants from 8 to 18 months at 8 time points. We used the data of the entire sample from decorated room sessions at 14 months and looking while listening sessions at 18 months. Thirty-five infant-caregiver dyads (20 females) participated in this study when the infants were 14 and 18 months old. All infants were full term, typically developing and growing in monolingual households. Seven infants were excluded due to the loss of video recording during decorated room sessions (3 infants) or not meeting the coding criteria of Looking While Listening task (4 infants). Thus, we continued with 28 participants in the following analyses. Fifteen caregivers (6 female) had at least 15 years of formal education and were categorized as high-educated; the remaining 20 caregivers (12 female) had a maximum of 8 years of formal

education and were categorized as low-educated. Data were collected in the Language and Communication Development Laboratory (LCDL) at Koç University.

2.2. Procedure and Materials

At the beginning of the study, demographic information (e.g., parents' education level, information about children) were collected from the mothers. At 14 months, mothers and infants participated in the Decorated Room sessions in the laboratory. Decorated room sessions were recorded with four cameras in each corner of the room. At 18 months, infants completed the Looking While Listening task. At the end of each visit, parents were given a small gift for their participation.

2.2.1. Decorated Room Paradigm

To elicit and measure the pointing behavior of infants and their mothers, we used the decorated room paradigm, which is a room with 19 objects hung on the four walls (Liszkowski et al., 2012). Caregivers were asked to carry their infants on their hips to provide the mother-infant dyads to make eye contact and look together at the items on the walls for 5 minutes. Before the experimenter left the participants alone in the room, the mothers were instructed to explore the room together with their infants without touching the items on the walls.

Figure 1.
Decorated Room Paradigm (Liszkowski et al. 2012)

The coding of the data was conducted using the ELAN software (Sloetjes & Wittenburg, 2008). We coded infants' whole-hand and index-finger points separately and caregivers' total points. Caregivers' and infants' pointing were coded according to the coding scheme of Liszkowski and Tomasello (2011). The coding of a pointing gesture started with the initiation of extending the arm with the whole hand or the index finger around an item or a location and ended roughly after retraction of the arm at least halfway. If there was a change of referents without retracting or the bringing down of the pointing arm, more than one point was coded for each change of referents. The coding was done by four coders. Five percent of the videos were randomly selected for calculating interrater reliability. Intraclass correlations were high among the 4 coders: Cronbach alphas ranged from .94 to .99.

2.2.2. Looking While Listening Task

Infants' real-time word comprehension and latency to find the matching referent for a word was assessed at 18 months using a version of the looking while listening (LWL) procedure (Fernald et al., 2008) on an eye-tracker. Infants sat on the caregivers' lap during all sessions, and caregivers were asked not to look at the screen. Infants were presented with two objects (one distracter and one target) on a screen while they heard the name of the target object in a sentence across 32 trials. Each stimulus sentence consisted of a carrier phrase with the target word in the final position, followed by an attention-getter (e.g. *Neredeymiş araba? Hadi bak bakalım. Bulabilir misin?* 'Where's the car? Let's look at that. Can you find it?'). On each trial, the two objects were shown simultaneously for 2 s prior to speech onset, remaining on the screen during the auditory stimulus until 1 s after the speech offset (figure). Between trials, the screen was blank for approximately 1 s. Each trial lasted approximately 7 s. When infants were watching the objects, their eye movements were recorded as a video with the eye-tracker . The coding of the data was performed using the ELAN software (Sloetjes & Wittenburg, 2008). We calculated the percentage of their eye movements to each object in only distracter-initial trials so that we can detect the shifts from the distractor to the target object and the latency of the shift in eye-gaze. We obtained three types of score by calculating (a) the proportion of trials in which the infant correctly shifted to the target object in distracter-initial trials, (b) average latency to shift the gaze from the distractor object to the target object among the distracter-initial trials and, (c) proportion of looking time at the target object relative to the total time they looked at both target and distractor objects within 300-1800 ms from the target word onset.

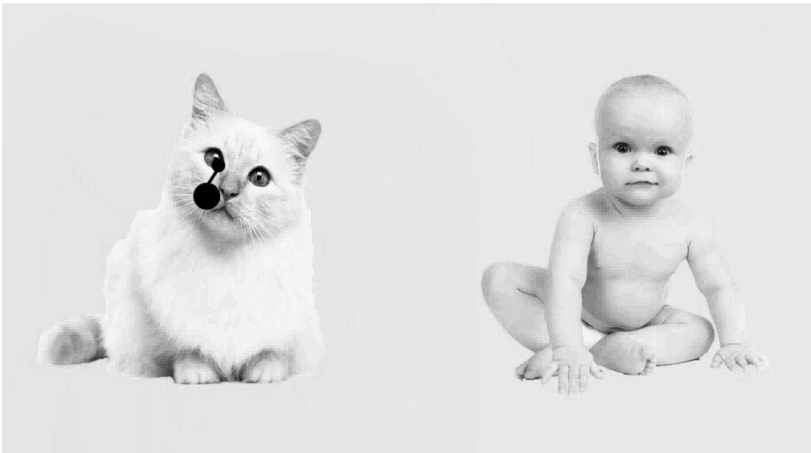

Figure 2
Looking-While-Listening Task (Fernald et al., 2008)

Note. Black points on face of cat represent infant's fixations on screen.

3. Results

The dependent variables included proportion of correct shift from the distractor object to the target object, average latency to shift the gaze from the distractor object to the target object, proportion of looking time to the target object at 18 months. The independent variables were infants' whole-hand pointing, index-finger pointing and total pointing frequency and mothers' total pointing frequency. In the following sections, we first present descriptive statistics of the dependent and independent variables. Then we examine the associations between infants' word comprehension and latency to find referents of word and their whole-hand pointing, index-finger pointing, total pointing frequency and mothers' total pointing frequency.

3.1. Infant and caregiver pointing

At 14 months, the average number of pointings by infants was 20.66 (range: 1 - 41, *SD* = 11.73). Infants' average number of whole-hand pointings was 8.52, with a range of 1 - 27 (*SD* = 7.4) and average number of index-finger pointings was 12.14, with a range of 0 - 29 (*SD* = 10.85). There was a significant difference between infants' different types of pointing. Infants' index-finger pointing (*M* = 12.14, *SD* = 10.85) frequency was higher than their whole-hand pointing (*M* = 8.52, *SD* = 7.4) at 14 months, $t(28) = 6.02$, $p < .001$. Caregivers' average number of pointings was 16.03 (range: 0 - 45, *SD* = 14.05).

3.2. Infant word comprehension

As mentioned before, we obtained three types of scores from infants' LWL task performance. On average, infants' proportion of correct shift from the distractor object to the target object was .75 (range: .33 - 1, *SD* = .22). Nine infants' scores had a top proportion value that is 1. Mean value of average latency to shift the gaze from the distractor object to the target object was 582 s (range: 164.33 - 1135.5, *SD* = 196.52). Lastly, the average proportion of looking time at the target object was .58 (range: .63 - .24, *SD* = .13).

Table 1
Descriptive Statistics of the Infants' and Caregivers' Pointing and Infants' LWL Scores

Variables	*M*	*SD*	Range
Caregivers-Total Point	16.25	14.27	[0-45]
Infant-Total Point	20.39	11.86	[1-41]
Infant-Index Point	11.96	11.02	[0-39]
Infant-Hand Point	8.43	7.52	[1-27]
Proportion of Correct Shift to the Target Object	.76	.21	[.33-1]
Latency to Shift to the Target Object (ms)	596.2	190.25	[222.33-135.5]
Proportion of Looking Time at the Target Object	.57	.13	[.24-.77]

3.3. Factors predicting infants' word comprehension and latency to find referents

We conducted linear regression analysis to examine whether infants' word comprehension skill and latency to find referents at 18 months are related to the pointing frequency of mothers and infants at 14 months.

Our first hypothesis was that the pointing frequency of mothers and infants at 14 months will both be related to infants' word comprehension skills at 18 months. Results showed that the frequency of mothers' pointing was not associated with infants' proportion of correct shift from the distractor object to the target object (β = -.004, p > .05), average latency to shift the gaze from the distractor object to the target object (β = -.732, p > .05), and proportion of looking time at the target object (β = -.004, p > .05). Similarly, results demonstrated that the frequency of infants' total pointing was not associated with their proportion of correct shift from the distractor object to the target object (β = .006, p > .05), average latency to shift the gaze from the distractor object to the target object (β

= -5.09, $p > .05$), and proportion of looking time at the target object ($\beta = .003$, $p > .05$).

Table 2
Regression Analysis Results for Mothers' Total Number of Points Predicting Looking While Listening Scores

Variables	B	SE	*t*	p
The Proportion of Correct Shifting to the Target Object	-.004	.003	-1.31	.20
Average Latency to Shift to the Target Object	-.719	2.61	-.27	.79
The Proportion of Looking Time at the Target Object	.002	.002	1.33	.19

Table 3
Regression Analysis Results for Infants' Total Number of Points Predicting Looking While Listening Scores

Variables	B	SE	*t*	p
The Proportion of Correct Shifting to the Target Object	.006	.003	1.92	.07
Average Latency to Shift to the Target Object	-.509	2.98	-1.70	.10
The Proportion of Looking Time at the Target Object	.003	.002	1.72	.10

Our other hypothesis was that infants' indexical pointing will be a better predictor of their later language abilities than whole-hand pointing. We found that the index-finger pointing frequency of infants at 14 months positively predicted the proportion of correct shifting to target object ($\beta = .009$, $p < .05$), latency to shift the gaze from the distractor object to the target object ($\beta = -7.62$, $p < .05$), and the proportion of infants' looking time to target objects ($\beta = .005$, $p < .05$) at 18 months. On the other hand, the frequency of infants' whole-hand pointing was not associated with proportion of correct shifting to target object ($\beta = -.005$, $p > .05$), latency to shift the gaze from the distractor object to the target object ($\beta = 3.62$, $p > .05$), and the proportion of infants' looking time to target objects ($\beta = -.002$, $p > .05$).

Table 4
Regression Analysis Results for Infants' Index Points Predicting Looking While Listening Scores

Variables	B	SE	*t*	p
The Proportion of Correct Shifting to the Target Object	.009	.003	2.66	.01*
Average Latency to Shift to the Target Object	-7.37	3.06	-2.41	.02*
The Proportion of Looking Time at the Target Object	.005	.002	2.19	.04*

* $p < .05$

Table 5
Regression Analysis Results for Infants' Whole-Hand Points Predicting Looking While Listening Scores

Variables	B	SE	*t*	p
The Proportion of Correct Shifting to the Target Object	-.003	.006	-.63	.54
Average Latency to Shift to the Target Object	3.14	4.92	.64	.53
The Proportion of Looking Time at the Target Object	-.001	.003	-.38	.71

4. Discussion

Infants' pointing production (e.g., Goldin-Meadow, 2007) and maternal pointing input (e.g., Iverson et al., 199) are critical for infants' concurrent and prospective language development. However, parent and infant point production have not been studied in relation to infants' word comprehension especially by separately considering infants' whole-hand and index-finger pointing forms. The current study investigated the effect of parental pointing gesture input and infants' early use of whole-hand and index-finger pointing at 14 months on infants' later word comprehension and latency to find referents at 18 months.

Our first hypothesis was that both the pointing frequency of mothers and infants at 14 months will be related to infants' word comprehension and latency to find referents at 18 months. Contrary to the previous findings (e.g., Iverson et al., 1999; Pan et al., 2005) we found that the total frequency of mothers' pointing is not associated with infants' word comprehension and latency to find referents.

In this study, we only counted the total pointing gestures produced by mothers. However, we did not examine whether joint attention (JA) was established with these points. The fact that mothers' pointings do not initiate joint attention, that is, infants do not respond to JA bids of mothers' pointing gestures. Therefore, even though the mother produces speech that accompanies their pointings, this is not enough to enable the child to learn information about that object.

Similarly, our results demonstrated that the frequency of infants' total pointing was not a predictor of their later language development. As we explained in the introduction, previous studies showed that the relation of pointing to receptive language was not always found (Colonnesi et al., 2008; Meltzoff 2008). Thus, our result corresponds to the literature. At this point, different hand shapes of infants' pointing gestures have different effects on later language development. In line with this, we also hypothesized that infants' indexical pointing will be a better predictor of their later language abilities than whole-hand pointing. We found that the index-finger pointing frequency of infants at 14 months predicted their later word comprehension and latency to find referents while the frequency of infants' whole-hand pointing was not associated with later language development. The first possible reason may be that the frequency of index-finger pointing increases at the beginning of the second year, while the frequency of whole-hand pointing may decrease, as we have also found. So, whole-hand pointing may not have a distinctive effect on the language development of infants during these months. Another possible reason may be that using indexical pointing gestures may signal to adults that they would like to learn about the objects gestured at. It may be that when infants point to an object, it becomes more likely to hear about that object from their addressee. On the other hand, infants' whole-hand pointing may be perceived as a reaching gesture by mothers. For this reason, mothers can give, bring closer, or move away from that object rather than producing descriptive, informative, or referential speech about the object pointed by infants.

In conclusion, this study furthered our understanding of the association between pointing gesture production, pointing gestural input, and language development. Importantly, our study contributed to research on infants' pointing gestures especially by separately considering whole-hand and index-finger pointing forms. Lastly, our findings highlight the unique role of the index-finger pointing on later language development.

References

Bates, Elizabeth, Benigni, Laura, Bretherton, Inge, Camaioni, Luigia, & Virginia Volterra. (1979). The emergence of symbols: Cognition and communication in infancy. New York: Academic Press.

Behne, Tanya, Liszkowski, Ulf, Carpenter, Malinda, & Tomasello, Michael. (2012). Twelve-month-olds' comprehension and production of pointing. *The British Journal of Developmental Psychology*, *30*(Pt 3), 359–375. https://doi.org/10.1111/j.2044-835X.2011.02043.x

Bekken K. Is There Motherese in Gesture? [Unpublished doctoral dissertation]. Chicago, IL: The University of Chicago; 1989

Blake, Joanna, Osborne, Patricia, Cabral, Marlene, & Gluck, Pamela. (2003). The Development of Communicative Gestures in Japanese Infants. *First Language*, *23*(1), 3–20. https://doi.org/10.1177/0142723703023001001

Boundy, Laura, Cameron-Faulkner, Thea, & Theakston, Anna. (2016). Exploring early communicative behaviours: A fine-grained analysis of infant shows and gives. *Infant Behavior and Development*, *44*, 86–97. https://doi.org/10.1016/j.infbeh.2016.06.005

Brooks, Rechele, & Meltzoff, Andrew N. (2008). Infant gaze following and pointing predict accelerated vocabulary growth through two years of age: a longitudinal, growth curve modeling study. *Journal of Child Language*, *35*(1), 207–220. https://doi.org/10.1017/s030500090700829x

Cameron-Faulkner, Thea, Theakston, Anna, Lieven, Elena, & Tomasello, Michael. (2015). The Relationship Between Infant Holdout and Gives, and Pointing. *Infancy*, *20*(5), 576–586. https://doi.org/10.1111/infa.12085

Colonnesi, Cristina, Rieffe, Carolien, Koops, Willem, & Perucchini, Paola. (2008). Precursors of theory of mind. A longitudinal study. British Journal of Developmental Psychology, 26, 561–577.

Colonnesi, Cristina, Stams, Geert Jan J. M., Koster, Irene, & Noom, Marc J. (2010). The relation between pointing and language development: A meta-analysis. *Developmental Review*, *30*(4), 352–366. https://doi.org/10.1016/j.dr.2010.10.001

Dimitrova, Nevena, & Özçalışkan, Şeyda. (2013). How Gesture Input Provides a Helping Hand to Language Development. *Seminars in Speech and Language*, *34*(04), 227–236. https://doi.org/10.1055/s-0033-1353447

Fernald, Anne E., Zangl, Renate, Portillo, Ana Luz, & Marchman, Virginia A. (2008). Looking while listening. Language Acquisition and Language Disorders, 97–135.

Ger, Ebru, Altınok, Nazlı, Liszkowski, Ulf, & Küntay, Aylin C. (2018). Development of Infant Pointing from 10 to 12 months: The Role of Relevant Caregiver Responsiveness. *Infancy*, *23*(5), 708–729. https://doi.org/10.1111/infa.12239

Goldin-Meadow, Susan. (2007). Pointing Sets the Stage for Learning Language - and Creating Language. *Child Development*, *78*(3), 741–745. ttps://doi.org/10.1111/j.1467-8624.2007.01029.x

Iverson, Jana M., Capirci, Olga, Longobardi, Emiddia, & Cristina Caselli, M. (1999). Gesturing in mother-child interactions. *Cognitive Development*, *14*(1), 57–75. https://doi.org/10.1016/s0885-2014(99)80018-5

Kita, Sotaro (Ed.). Pointing. Where language, culture and cognition meet (pp. 69–84). Mahwah, NJ: Erlbaum.

Liszkowski, Ulf, & Tomasello, Michael. (2011). Individual differences in social, cognitive, and morphological aspects of infant pointing. *Cognitive Development*, *26*(1), 16–29. https://doi.org/10.1016/j.cogdev.2010.10.001

Liszkowski, Ulf, Brown, Penny, Callaghan, Tara, Takada, Akira, & de Vos, Connie. (2012). A Prelinguistic Gestural Universal of Human Communication. Cognitive Science, 36(4), 698–713.

Masataka, Noburo. (2003). From index-finger extension to index-finger pointing: Ontogenesis of pointing in preverbal infants. In S.

Murphy, Catherine M. (1978). Pointing in the context of a shared activity. Child Development, 49, 371–380.

Özçalişkan, Şeyda, & Goldin-Meadow, Susan. (2005). Do parents lead their children by the hand? *Journal of Child Language*, *32*(3), 481–505. https://doi.org/10.1017/s0305000905007002

Özçalışkan, Şeyda, Adamson, Lauren B., & Dimitrova, Nevena. (2015). Early deictic but not other gestures predict later vocabulary in both typical development and autism. *Autism*, *20*(6), 754–763. https://doi.org/10.1177/1362361315605921

Pan, Barbara Alexander, Rowe, Meredith L., Singer, Judith D., & Snow, Catherine E. (2005). Maternal Correlates of Growth in Toddler Vocabulary Production in Low-Income Families. *Child Development*, *76*(4), 763–782. https://doi.org/10.1111/1467-8624.00498-i1

Rowe, Meredith L. (2000). Pointing and talk by low-income mothers and their 14-month-old children. *First Language*, *20*(60), 305–330. https://doi.org/10.1177/014272370002006005

Rowe, Meredith L., & Goldin-Meadow, Susan. (2009a). Differences in Early Gesture Explain SES Disparities in Child Vocabulary Size at School Entry. *Science*, *323*(5916), 951–953. https://doi.org/10.1126/science.1167025

Veena, Kadiyali D., & Bellur, Rajashekhar. (2013b). Development of communicative gestures in normally developing children between 8 and 18 months: An exploratory study. *Journal of Early Childhood Research*, *13*(2), 150–164. https://doi.org/10.1177/1476718x13489813

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