Twelve-month-olds' vocal production during pointing in naturalistic interactions: Sensitivity to parents’ attention and responses

Julie Gros-Louis*, Zhen Wu

Department of Psychology, University of Iowa, 11 Seashore Hall E, Iowa City, IA 52242, United States

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There have been many rich, naturalistic studies documenting prelinguistic communicative abilities that suggest that the integration of alternating eye gaze, vocal behaviors, and nonverbal gestures are indicative of intentional communication (e.g., Bates, Camaioni, & Volterra, 1975; Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Dore, 1974; Ninio & Bruner, 1978; Trevarthen & Hubley, 1978). Many observational studies have noted the increase in pointing and concurrent vocalizations from the age of 12 months into the 2nd year, primarily during the acquisition of first words and later language abilities (e.g., Bakeman & Adamson, 1986; Butcher & Goldin-Meadow, 2000; Carpenter et al., 1998; Goldin-Meadow, 1998; Masur, 1983; Murphy, 1977); however, some studies have also documented gestures with concurrent prelinguistic vocalizations in communicative interactions prior to the acquisition of first words (Bates, 1976; Franco & Butterworth, 1996; Leroy, Mathiot, & Morgenstern, 2009; Messinger & Fogel, 1998). Although there are many studies that document gestures and co-occurring vocalizations, few have examined the potential intentional use of communicative behaviors, particularly vocalizations, in social interactions (but see Camaioni, 1992; Franco & Butterworth, 1996).

There has been an increase in research to investigate whether infants point with the intent to communicate or not. Researchers suggest that infants point initially for the self, without communicative intent, yet parents respond to infants’ pointing as if it was communicative (Carpendale & Lewis, 2004; see also Iverson & Thal, 1998). Similarly, researchers have suggested that communicative pointing may emerge out of initially non-communicative pointing and can be identified based on whether or not infants alternate eye gaze to their parent and a target when they point versus pointing without eye gaze alternation (Desrochers, Morissette, & Ricard, 1995; Franco & Butterworth, 1996). Recent experimental studies in which a social partner's attention and response to an infant's point are manipulated have helped to reveal the behaviors that are indicative of communicative pointing. For example, when adults did not share infants' interests or misidentified their interests, infants pointed repeatedly and looked at adults more compared to when adults responded with interest and...
enthusiasm to the object that infants were pointing to (Liszkowski, Carpenter, & Tomaszello, 2007a, 2007b). These findings suggest that pointing is often performed with the goal to share interest and attention and to communicate about a referent, as infants show variation in pointing behavior and gazing behavior as a function of recipients’ responses.

Although numerous studies have documented that infants as young as 12 months old understand the social communicative function of pointing (Tomasello, Carpenter, & Liszkowski, 2007), how well infants understand the possible function of their prelinguistic vocalizations is unclear. The few studies that have experimentally examined when vocalizations co-occur with gestures have shown that infants increased their vocal production when a social partner was attending to them but did not react by sharing attention and interest in what the infants were pointing to (e.g., Liszkowski et al., 2004, 2007b; Liszkowski, Albrecht, Carpenter, & Tomaszello, 2008). Therefore, the vocalizations appear to call attention to the pointing gesture when the outcome was not successful rather than to gain the adults’ attention when adults are looking elsewhere or engaged in another activity.

In contrast to the findings in experimental studies, observations from naturalistic interactions have documented vocalizations with gestures that appear to serve the function of getting adults’ attention when adults are not currently attending (Leroy et al., 2009; Jones & Zimmerman, 2003). The advantage of these descriptive case studies is the examination of gestures in detailed naturalistic interaction (“realistic dyadic settings” – see Murphy, 1977), although one drawback is, often, the small sample size. As noted by Tomaszello et al. (2007), there are few systematic studies of infant pointing behavior in naturalistic interactions. Therefore, the purpose of the present study is to examine infants’ pointing and concurrent vocalizing in naturalistic interactions with mothers and fathers. We aim to determine if infants’ vocalizations serve as a means of communication during the process of pointing. It is common to see infants pointing together with a vocalization, usually one syllable, such as “ah” or “da”, in naturalistic observations (e.g., Leroy et al., 2009). What needs to be examined, however, is whether or not infants variably produce vocalizations with pointing behavior as a function of adults’ attention and responses during ongoing interactions, as has been documented in experimental settings.

As part of larger study on maternal and paternal responsiveness to infants’ prelinguistic vocalizations, we randomly selected thirty 12-month-old infants (15 males and 15 females) to examine their pointing and concurrent vocal behavior. Of these, only twenty produced points and were included in the current study (10 males, 10 females; mean age: 369.8 ± 14.9 days). Participants had been selected for a larger study from either the Child Volunteer Registry of the University of Iowa psychology labs or from birth records from Johnson and Linn Counties, IA. Participants were primarily Caucasian of middle socioeconomic status and the majority of parents worked outside of the home, based on a brief demographic questionnaire that was administered. Participants played with their mothers and fathers separately for 30 min, counterbalanced for order of visit to the lab (range of days between visits: 0–19 days, mean = 4.45 days ± 4.93 days). Participants engaged in natural freeplay interactions in a playroom that contained a variety of age-appropriate toys. Parents were instructed to play as they would at home. Interactions were recorded with three wall-mounted video cameras (Sony EVI-D100) routed through an audio–video mixer (Datavideo SE-800AVK) to allow for selection of the best camera angle or picture-in-picture recording to determine infants’ and parents’ attentional focus. Audio recordings were made using a wireless microphone (Sennheiser ew112G2) sewn into overalls worn by the infant.

The second author and a second coder coded whole-hand points and index-finger points and noted if there was a vocalization during the infants’ point or after parents’ responses (i.e., within 2 s of parents’ responses). In instances where parents did not respond, infant vocalizations after the 2-s potential response window were coded. Points were defined as extension of the arm and index finger or open hand extended in the direction of an object (Thal & Tobias, 1992). Whole-hand pointing and index-finger pointing were determined based on hand shape. Whole-hand points included ritualized reaches and palm points (Iversen & Goldin-Meadow, 2005). Vocalizations during a point were those that occurred any time between the onset of the arm extension until the arm was drawn back and the index finger or hand was no longer extended. Interrater agreement for identifying pointing events was 75.7%. For those points that were mutually identified, agreement for index-finger vs. whole-hand points was 86% (κ = 0.71), for vocalizations during a point was 87% (κ = 0.89), and for vocalization after a parents’ response was 87% (κ = 0.68).

Because visual checking (i.e., infant look to parent) during reaching or pointing is thought to be indicative of communicative intent (cf. Bates, 1976; Franco & Butterworth, 1996; Thal & Tobias, 1992), we determined if whole-hand points, which included ritualized reaching, and index-finger pointing were produced in similar communicative contexts by coding visual checking before, during and after points (Franco & Butterworth, 1996). Interrater agreement for visual checking was: before points 86% (κ = 0.69), during points 89% (κ = 0.74), and after points 95% (κ = 0.88).

Caregiver attentional focus immediately preceding infants’ points were coded in the following four categories: (1) AI = attending to infant; (2) AO = attending to the object that the infant points to; (3) ALO = alternating eye gaze between the infant and object that the infant points to; (4) RO = attending to a different object than the one that the infant points to. These categories correspond to those of Bakeman and Admason’s (1984) coding of infants’ attention: persons, passive joint attention, coordinated joint attention, and onlooking, respectively. Cohen’s kappa for adult attention before pointing was 0.73.

Caregiver responses were coded when caregivers responded within 2 s of infants’ points and were based on how they related to the focus of infants’ points (i.e., the object that infants were pointing to). Sensitive responses included comments or actions on the object that the infant was pointing to. Redirective responses, on the other hand, were comments or actions on objects that were not the focus of infants’ points. An additional category, caregiver questions, was coded if the caregiver asked the infant a question that was related to what the infant was pointing to in response to the point. Questions, therefore,
Table 1
Descriptive data of parental attention, parental responses, infant points, and infant vocalizations when playing with father or mother.

<table>
<thead>
<tr>
<th></th>
<th>Father</th>
<th></th>
<th></th>
<th>Mother</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>M</td>
<td>SD</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Parental attentiona</td>
<td>AI</td>
<td>0</td>
<td>27</td>
<td>4.81</td>
<td>6.83</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>AO</td>
<td>0</td>
<td>2</td>
<td>1.50</td>
<td>0.71</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>RO</td>
<td>0</td>
<td>1</td>
<td>0.11</td>
<td>0.33</td>
<td>0</td>
</tr>
<tr>
<td>Parental responsesa</td>
<td>Question</td>
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<td>3</td>
<td>1.36</td>
<td>1.29</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>0</td>
<td>16</td>
<td>2.31</td>
<td>4.31</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Red</td>
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<td>1</td>
<td>0.08</td>
<td>0.90</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Sensitive</td>
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<td>14</td>
<td>3.86</td>
<td>3.88</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Infants' pointsa</td>
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<td>28</td>
<td>4.95</td>
<td>7.13</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Vocalization during pointsb</td>
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<td>1</td>
<td>0.53</td>
<td>0.39</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Vocalization after pointsb</td>
<td>0</td>
<td>1</td>
<td>0.21</td>
<td>0.26</td>
<td>0</td>
</tr>
</tbody>
</table>

a Frequency.

b Proportion.

are a sensitive response, but unique in that sensitive and redirective responses are comments, whereas we predicted that questions might elicit a response from the infant because they are often to clarify the purpose of the point (“Do you want me to get that?” “Did you see that last time?”). Cohen’s kappa for adult responses was 0.77.

As shown in Table 1, infants did not differ in their vocal production during pointing when interacting with their mom compared to their dad, \( t(13) = 1.03, p = 0.16 \). Infants also did not differ in their pointing behavior during visits with mom compared to dad, \( t(19) = 0.12, p = 0.91 \); however, repeated measures analysis (number of infant points is the dependent variable and visit and parent order are independent variables) found a significant interaction effect for parent and visit order on infant pointing behavior \( F(1,18) = 6.12, p = 0.02, \eta^2 = 0.25 \), observed power = 0.65 (Fig. 1). Generally, infants showed more pointing during their second visit to the lab than during their first visit to the lab, \( t(19) = 2.54, p = 0.02 \), which seems to be a result of infants producing fewer points when they came with their fathers in the first visit. Infants produced fewer points in their first visit when they came with their fathers first compared to when they came with their mothers first, \( t(18) = 2.21, p < 0.05 \), but there were no significant differences in their second visit, \( t(18) = 1.16, p = 0.27 \). Furthermore, comparing individual infants’ first and second visits revealed that infants produced significantly more points in the second visit with their mothers than points in the first visit with their fathers \( (4.50 \pm 3.58 \text{ vs. } 1.80 \pm 2.15), t(9) = 2.32, p < 0.05 \); whereas, infants did not show a significant increase in points with their fathers in the second visit compared to points with their mothers on the first visit \( (8.10 \pm 8.97 \text{ vs. } 5.10 \pm 4.20), t(9) = 1.51, p = 0.17 \).

Paired t-test found no significant differences in mothers’ and fathers’ focus of attention before infants’ points or responses to infants’ points, \( p > 0.05 \) (see Table 1). Moreover, mothers and fathers did not differ in the relative proportion of their different types of responses to infants’ points (proportions of responses – sensitive: 0.44 vs. 0.47; none: 0.20 vs. 0.21; ask questions: 0.21 vs. 0.12; redirective: 0.15 vs. 0.20, \( p > 0.05 \)). Therefore, in the following analyses, we combined infants’ data from play sessions with mothers and fathers. In addition, infants’ visual checking was similar for whole-hand compared to index-finger points before, during, and after pointing \( (t(19) = 1.20, p = 0.25; t(19) = 0.64, p = 0.53; t(19) = 0.11, p = 0.91, \) respectively). Therefore, points were combined across categories in the following analyses.

Repeated measures analysis (proportion of vocalization during pointing is the dependent variable and parental attentional state before infants’ points is the independent variable) showed that infants’ vocal production during pointing varied relative

![Fig. 1. The frequency of infants’ pointing during first and second visits with mothers or fathers.](image-url)
to parents’ attentional states, $F(3, 17) = 9.70, p = 0.001, n^2 = 0.63$, observed power = 0.99. Further analysis found that infants were more likely to vocalize when the parent was looking at the infant (AI) or looking at something other than the object of infants’ attention (RO) than when parents were already attending to the object that the infants were pointing to (AO), $p’s < 0.05$ (Fig. 2). Thus, we combined AO and AIO together to form the categorization of ‘target,’ which means that the parent was focusing on the target object that the infant was focused on, and combined AI and RO together to form the categorization of ‘non-target,’ which means that the parent was not focusing on the target. We found that infants were more likely to vocalize when their parents were not focusing on the target object than when their parents were already attending to the target object ($0.54 ± 0.34$ vs. $0.10 ± 0.18$), $t(19) = 5.27, p < 0.001$.

After infants pointed, if parents responded sensitively to infants’ pointing, i.e., commenting or acting on the object that the infant pointed to, infants were significantly less likely to vocalize in response, $t(19) = 15.30, p < 0.001$; however, if parents redirected infants’ attention to other objects, although very infrequent, infants appeared to be more likely to respond with a vocalization, $t(4) = 3.18, p = 0.03$. Similarly, if parents did nothing to respond to infants’ pointing, infants tended to vocalize, $t(12) = 1.85, p = 0.08$. Lastly, infants did not show a difference in vocal production in response to questions, $t(11) = 0.81, p = 0.44$ (Fig. 3).

Results suggest that infants vocalize during the process of pointing in naturalistic interactions to direct parents’ attention to the target objects, given that infants’ vocal production varied as a function of parents’ attentional states. Infants were more likely to vocalize when pointing if their parent was looking at them or looking elsewhere than if their parent was already looking at the target object. Additionally, infants tended to vocalize more after pointing if their parents did not respond or if they responded redirectively, i.e., about something other than what the infant was pointing to (see similar results for 18-month olds, Liszkowski et al., 2008) whereas infants were less likely to vocalize if parents responded sensitively to infants’ pointing (e.g., make comments about the object the infant was pointing to), which suggests that infants were vocalizing to direct attention to the target object.

Infants were as likely to vocalize or not to vocalize after parents asked questions. Questions were related to the object of the infants’ point. Thus, the reason might be that infants would either vocalize to “answer” the question, or not vocalize

Fig. 2. Mean proportion and standard error of infants’ vocalizations during points relative to parents’ attentional states. AI = attending to infant; AO = attending to the object that the infant points to; AIO = alternating eye gaze between the infant and object; RO = attending to a different object than what the infant points to.

Fig. 3. Mean proportion of infants’ vocalizations after pointing relative to parents’ responsiveness to the pointing. AQ = ask question.
because their pointing already succeeded in attracting parents' attention to the target of the point. A recent study documented that gestures function to request a demonstration or information, serving a utilitarian, interrogative function rather than serving the purpose of sharing or helping (Southgate, van Maanen, & Csibra, 2007). Future research should examine how the specific content of parents’ questions surrounding the pointing event could account for these differences in vocal production following parent questions.

Generally, infants pointed more during their second visit than their first visit. One possible explanation is that infants' pointing behavior changed in between visit one and visit two; however, we did not find a significant relationship between the length of the break between visits and infants' increased number of points ($r = -0.10, p = 0.35$), suggesting that differences are not related to developmental changes. Infants' production of more points in the second visit seemed to be a result of fewer points in their first visit, but only with their fathers. This may be related to the fact that, in our sample, infants spent most of their time with their mothers, even in families in which both mothers and fathers worked outside of the home. Therefore, infants who came with their fathers to the lab for the first time may take longer to become comfortable with the new lab setting, which may reduce exploratory behavior. Future work is needed to examine caregiver-infant interactions for specific behaviors that could account for these differences, as specific aspects of parents' behavior, in addition to caregiver–infant relationship, may influence exploratory behavior in novel environments (cf. Lamb, 1976; Sorce & Emde, 1981).

The current findings are similar to prior experimental findings (e.g., Liszkowski et al., 2008), but show that, in naturalistic interaction, infants' vocalization gains parents' attention when they are not attending, in addition to emphasizing the pointing gesture when parents do not respond about the target of the infants' point. Liszkowski (2011) suggests that infants' pointing is both intentional and referential based on experimental manipulations that reveal infants' pointing behavior varies as a function of social partners' interest, attention, and knowledge. The observations from the current study also suggest that infants vocalize to achieve shared attention and to communicate about the object of a point in real-time naturalistic interaction; however, the findings are based on a heterogeneous sample. Future studies should examine gestural behavior and responses to gestures in samples of infants of varying socioeconomic status and cultural backgrounds, as children's gestures and maternal responsiveness have been shown to vary across cultures and socioeconomic status (e.g., Bornstein et al., 1992; Hoff, 2003; Iverson, Capirci, Volterra, & Goldin-Meadow, 2008).

Although we found that infants produce vocalizations concurrently with pointing when adults were not attending, it is not clear if infants vocalize concurrently with the gestures to intentionally call attention to the gesture so as to orient adults’ attention to the object that is being pointed to. An alternative explanation is that infants vocalize, with or without gestures, because vocalizations have received responses in the past. Collins (1979) has suggested that vocalizations occurring concurrently with attentional focus on an object are initially coincidences rather than being under voluntary control, but through responses to the vocalizations, infants learn about their effectiveness. Therefore, infants may come to produce vocalizations in social interactions (Locke, 1996). A recent longitudinal study provides some support for this suggestion. Maternal sensitive responses to infants' vocalizations in previous months predicted an increase in the production of vocalizations, but only those that are directed to mothers (i.e., looking to mothers) in social interactions (Gros-Louis, West, & King, 2010, submitted for publication). This finding points to a role for maternal responsiveness on infants’ vocal production concurrent with eye gaze to a social partner, which is suggestive of communicative intent (cf. Bates et al., 1975; Franco & Butterworth, 1996). In addition, maternal sensitivity has been shown to relate to infants' triadic communicative abilities (Hobson, Patrick, Crandell, Garcia Perez, & Lee, 2004). Future work is needed to clarify the effects of maternal responsiveness on the development of the functional use of vocalizations in social interactions (e.g., Paavola, Kunnari, & Molinain, 2005).

One of the few prior studies of the intentional use of vocalizations (in the absence of pointing) indicates that infants must first develop causal understanding to develop the ability to intentionally influence the behavior of others. Harding and Golinkoff (1979) examined infants’ use of vocalizations to get their mothers to help them obtain or manipulate an object and infants’ causal knowledge. Results showed that infants’ use of vocalizations to attempt to influence maternal behavior related to their causal knowledge, as assessed by Piagetian causality tasks (similar to those used in the Early Social Communication Scales – Mundy et al., 2003) that reflect infants’ understanding of adults as autonomous agents. Others have also proposed that infants’ ability to use declarative points to share attention and interest are similarly indicative of their socio-cognitive abilities and knowledge of others as mental agents (Tomasello et al., 2007). It is debated, however, whether or not 12-month-old infants can have knowledge of others’ mental states and take goal-directed action to change those mental states (see D’Entremont & Seamans, 2007, for a ‘lean’ interpretation of infants’ pointing behavior).

The findings from this study of infants’ pointing and concurrent vocalizing in naturalistic interactions reveal flexible communicative abilities. Although longitudinal studies have documented the emergence of combined communicative behaviors (e.g., Messinger & Fogel, 1998), little is known about what influences their development. Researchers should consider the role that infants’ behavior and maternal responsiveness play in the development of intentional communication (e.g., Paavola et al., 2005). Longitudinal studies combining experimental and observational methods should explore the development of infants’ causal understanding, in addition to their production of communicative behaviors in social interactions and the responses they receive to these behaviors, as maternal responsiveness influences developmental changes in phonology, cognitive, social and linguistic abilities (Dunst, Lowe, & Bartholomew, 1990; Goldstein & Schwade, 2008; Landry, Smith, Miller-Loncar, & Swank, 1997; Tamis-LeMonda, Bornstein, & Baumwell, 2001). Studies examining individual variability in infants’ causal understanding as it relates to their social interactions can contribute to our understanding of the relationship between cognitive and social influences on the development of complex communication.
References


