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Brief report

Influence of vocal cues on learning about objects in joint attention contexts

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Abstract

An experimenter taught infants about a novel toy in two joint attention conditions, one with and one without vocal cues. In test trials, infants viewed the familiar toy and a novel toy. Infants in the *Joint Attention plus Voice* condition looked significantly longer to the novel toy.

Keywords: Vocal cues; Joint attention; Infancy; Development; Learning

In order to learn new information infants must detect and use social cues that are intended for them. It is know that by the middle of the second year, infants selectively use social cues such as eye contact to learn the names of new objects (Baldwin, 1993). Even earlier in ontogeny, infants are sensitive to the relevance of dyadic social cues that are directed toward them. For example, by 2–3 months of age, infants look longer at an adult who is providing contingent and potentially relevant social information compared to an adult who is delayed or providing ambiguous social cues (Nadel, Carchon, Kervella, Marcelli, & Réserbat-Plantey, 1999; Striano, Henning, & Stahl, 2005). The same general pattern holds in later development, and in the context of triadic (infant–object–adult) interactions. In one recent study, infants sat across from two adults and played with objects. One of the adults provided contingent social cues in the context of play and the other adult provided social cues that were delayed relative to those of the contingent adult. At one point an object in the room suddenly started making sounds, and the authors examined the question of which adult the infant looked to for information. At 12 months of age, infants understand the referential quality of others' gaze (Brooks & Meltzoff, 2005; Woodward, 2003) and selectively look toward the contingent partner (see also, Walden & Baxter, 1988). In sum, early in ontogeny infants are sensitive to social cues directed toward them and toward external events. However, the function of these cues for early learning is much less understood.

It is essential for infants to detect the relevance of social information directed at the self, and often these social cues are used to refer to some external event or situation in the local environment. Recent research shows that already by 4

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months of age infants use others' eye gaze cues to direct their attention toward objects (Reid & Striano, 2005) and that by 9 months of age, the infant brain shows enhanced processing of objects that are cued by joint attention interactions (Striano, Reid, & Hoehl, 2006). In these joint attention interactions, the adult looked at the infant and then directly to an object while maintaining positive tone of voice and facial expressions. These interactions were compared to a condition in which the adult only looked at the object and not to the infant, but while maintaining a positive facial expression and tone of voice. In sum, these studies point to the role of eye contact in early infant learning. Another cue that is often overlooked is the role of vocal cues in the establishment of joint attention (see Mumme, Fernald, & Herrera, 1996; Vaish & Striano, 2004). The voice is an important aspect of early infant–adult interaction. Across cultures, adults talk to infants using "motherse" or infant-directed speech (see Falk, 2004 for an overview), and infants preferentially attend to people who talk in infant-directed speech (Cooper & Aslin, 1990; Fernald & Kuhl, 1987; Werker, Pegg, & McLeod, 1994). The question of what infants learn from infant-directed vocal cues in the context of joint attention interactions remains an open question. In the current study, we assessed how adult positive vocal cues influence infant learning about objects in joint attention contexts.

Ten to 13-month-old infants interacted with an adult in two different contexts. Each infant was randomly assigned to one of the following two conditions. In the *Joint Attention plus Voice* condition, an adult female experimenter (E1), with a positive facial expression, encouraged the infant to look at a toy, looking alternately to the infant and the toy and using positive phrases as "Oh nice" or "It is pretty" (E1 spoke these phrases in German). The *Joint Attention Only* condition was exactly the same, except that E1 looked alternately between the infant and the toy, smiling, but without speaking. In following test trials, infants were presented with the "familiar" toy and a novel toy.

We predicted that infants would look longer to the novel object following the *Joint Attention plus Voice* condition, indicating that vocal cues helped infants to guide their attention and to learn about the familiarization object.

1. Participants

Thirty-one infants were included in the final sample ($M = 11$ months and 17 days, S.D. = 21.21 days, range = 10 months 19 days–12 months 24 days, 16 males and 15 females). One additional infant was tested but not included due to fussiness. Participants were recruited by telephone from a database consisting of a list of names of infants whose parents had volunteered to participate in studies of child development. All infants were full-term and healthy, and cared from at home primarily by their biological parents. Infants were White and were living in a mid-size city in the east of Germany. Infants received a toy for their participation.

2. Apparatus and stimuli

Infants were tested in a quiet room of the infant laboratory. Curtains surrounded the testing area to prevent any possible visual distraction. Infants were seated on their mother's lap for the entire procedure. Mothers wore a pair of opaque sunglasses to avoid any influence on the direction of infants' gaze. During the familiarization phase, an adult female experimenter (E1) sat directly across a table, about 70 cm from the infant (see Fig. 1). One object, a brightly colored stuffed animal (a dolphin or a turtle) was placed midway between the infant and E1 approximately 40° to the right or the left of the infant (counter-balanced across infants). During the following test trials, the familiarization object was paired with a novel object, placed opposite the infant and equidistant from the familiar object. At the beginning of each experimental phase, a white screen was raised to reveal the stimuli to the infant. At the end of each phase the white screen was lowered from the ceiling to block the infant's view as E1 arranged the toys on the table. Two video cameras recorded the familiarization phase and the test trials: the first captured the infant's face, and the second one recorded the actions of E1. A second experimenter (E2) was positioned behind a curtain out of view of the infant, monitoring the infant on a video screen, and signaling to E1 as to when certain phases of the experiment began and ended.

3. Procedure

The experimental session began when the screen was raised to reveal E1 and the familiarization object (shielded with a piece of cardboard). The right-left positioning of the object was counter-balanced across infants. After eye contact with the infant had been established, E1 removed the cardboard and the familiarization phase (*Joint Attention*

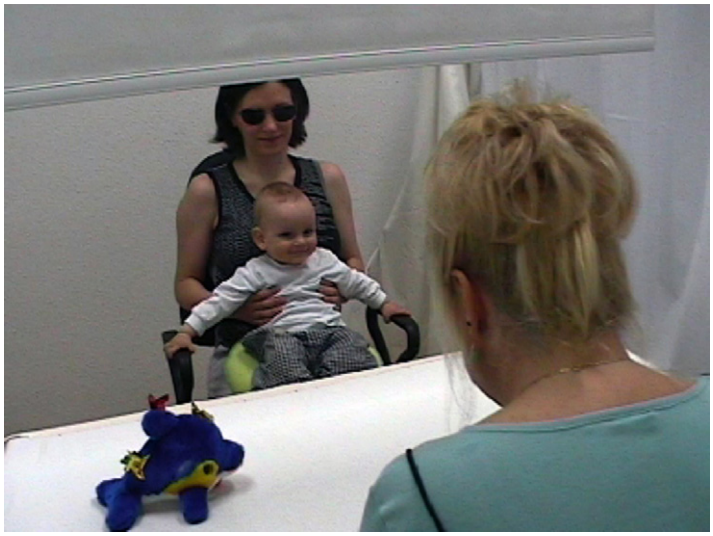

Fig. 1. Example of experimental set-up.

plus Voice ($N = 16$) or *Joint Attention Only* ($N = 15$)) began. Behind a curtain, and out of the sight of the infant, E2 monitored when the infant was looking at and away from the familiarization object, and pressed a computer key to manipulate a computer's timing program accordingly. Once the infant had accumulated a total of 20 s total looking time toward the familiarization object, the screen was lowered.

Immediately following the familiarization phase, infants were tested in two 10 s trials in which the familiar object was paired with a novel object. The right-left positioning of the novel object on the first trial was counterbalanced across participants. The position of the objects was reversed during the second trial. During the test trials, E1 hid behind a curtain and was not visible to the infant. Thus, no social cues at all were available to the infant during test trials.

4. Coding

Video data were scored by a coder blind to the experimental hypotheses. One hundred percent of the video recordings were scored by a second coder to assess reliability. The Pearson's correlation for infant gazing was .96.

The primary dependent measures were the total looking times to the novel versus familiar objects. Preliminary analyses revealed no significant effects of sex on looking time at the familiar or at novel objects. In addition, we found no significant effects of familiarization toy (turtle or dolphin) or the side to which the familiar toy was placed. These variables were therefore collapsed in subsequent analyses. A significant negative correlation was observed for age and looking time at the novel object in test trial 1 ($r = -.50$, $p < .005$). Age was then used as a covariate in subsequent analyses.

For the familiarization phase a one-way ANCOVA was performed, with condition (*Joint Attention plus Voice–Joint Attention Only*) as the between-subjects factor and the total familiarization length as the dependent variable. No significant effects were found (condition: $p > .82$; *M Joint Attention plus Voice* = 215.5 s, S.D. = 184.08; *M Joint Attention Only* = 229.8 s, S.D. = 176.19). Using the total gazing duration toward E1 during the familiarization phase we obtained the same result (condition: $p > .54$; *M Joint Attention plus Voice* = 105.75 s, S.D. = 98.96; *M Joint Attention Only* = 134.93 s, S.D. = 151.61).

A repeated measures 2 × 2 ANCOVA was performed in test trial 1, with object (familiar versus novel) as the within-subjects factor and condition as the between-subjects factor. Fig. 2 shows infant looking times to each object during test trials. We found a significant effect of age ($F_{(1,28)} = 5.75$, $p < .03$), condition ($F_{(1,28)} = 12.02$, $p < .002$), and object ($F_{(1,28)} = 7.07$, $p < .02$). The age × object interaction was also significant ($F_{(1,28)} = 6.85$, $p < .02$). As shown in Fig. 1, infants in the *Joint Attention plus Voice* condition looked to the novel toy significantly longer than did infants in the *Joint Attention Only* condition (Sheffé post hoc test, $p < .04$). The same ANCOVA performed in test trial 2 was not significant for any of these factors (condition: $p > .92$).

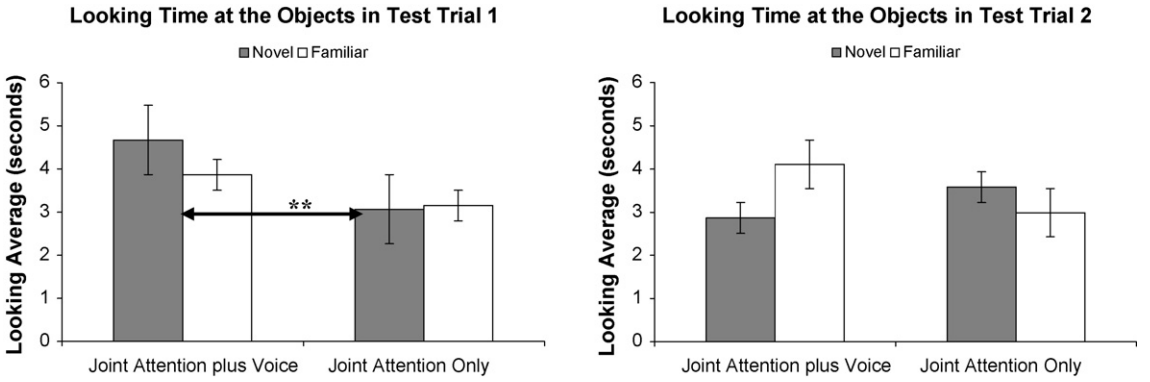

Fig. 2. Looking times to novel and familiar objects during test trials 1 and 2. Asterisks (**) indicate significance at the $p = .05$ level (looking time to novel toy across conditions).

In this study, we found evidence that vocal cues are an important component in joint attention interactions involving an infant, a novel toy, and an interactive adult. Specifically, we found a significantly larger mean novelty preference score following joint attention with vocal cues relative to a joint attention interaction in which no vocal cues were provided. Because the total time required for infants to accumulate 20 s of looking time to the familiarization toy did not differ across conditions, it is not likely that greater exposure to the social interaction or to the toy influenced these results. In other words, neither group of infants was engaged in the social interaction longer than the other group, and so it is unlikely that our results can be explained in terms of additional time spent with the toy or with the adult experimenter. This suggests that a human interaction, as in the familiarization phase, is always interesting to the infant, although the nature of the interaction influences the information that the infant is able to extract. In addition, we found a negative correlation between age and looking time to the novel toy, suggesting that object processing becomes increasingly efficient with age.

A large body of research has examined the role of facial expressions and positive and negative affect in social referencing and other aspects of social cognition (e.g. Klinnert, Emde, Butterfield, & Campos, 1987; Walden & Ogan, 1989). It is clear that these cues play a crucial role in the ways that infants interpret social information. However, these factors comprise only a portion of communicative signals. Because infants are exposed to multimodal cues in social interactions (Bahrick & Lickliter, 2002; Lickliter & Bahrick, 2001; Walker-Andrews & Bahrick, 2001), studies controlling specific aspects of communication are necessary to discern the relative importance of individual components, such as facial expressions, movement, and vocal cues. Only a limited number of studies have examined the importance of the voice in triadic attention and social referencing. These studies have provided evidence for the important role of vocal cues, a result that is consistent with our own findings.

For example, in a recent study, Vaish and Striano (2004) examined the role of vocal cues in a social referencing task with 12-month-old infants. On a visual cliff, infants received either vocal only, facial only, or a combination of vocal and facial cues from mothers. Infants crossed the obstacle faster in the conditions in which mothers supplied both vocal and facial or vocal only cues relative to when mothers provided only facial cues. These results suggest that vocal signals were important for infants in terms of gathering information in a potentially threatening situation.

Mumme et al. (1996) investigated the effects of both facial and vocal cues in a triadic attention paradigm involving novel toys. Twelve-month olds saw their mothers look at a toy while displaying either positive, negative of neutral affect in a *Face Only* condition. In a *Voice Only* condition, the mothers had their back turned to the infant, while speaking about the toy in a positive, negative or neutral tone. Infants responded by looking longer to the mother, displaying more negative affect, and less toy proximity when mothers spoke in a fearful tone relative to when only facial cues were provided. These results suggest that the voice is a powerful social stimulus in terms of guiding infants' behavior.

Taken together, these studies suggest an important role of vocal cues for infants' interpretation of social stimuli. Our present results support this hypothesis. In a joint attention interaction, infants showed a higher novelty preference following the *Joint Attention plus Vocal* relative to the *Joint Attention Only* social interaction. Given that higher novelty preference is indicative of greater information processing (e.g. Hunter & Ames, 1988), the present results suggest that vocal cues significantly enhanced object learning in infants at 1 year of age. Future studies should examine the roles of

other cues utilized in triadic interactions, such as body movement and affect. In addition, future research should seek to understand how the importance of specific social cues may change as a function of age.

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