

BRIEF REPORTS

Emergence of Selective Social Referencing in Infancy

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Seven and 10-month-old infants were presented with a remote-controlled toy dog that intermittently barked at 30-sec intervals as they faced an experimenter who either attended to them (look toward condition) or looked away (look away condition). Seven-month-old infants' looking toward the experimenter was significantly greater after the dog barking events compared to before regardless of experimental condition. In contrast, 10-month-old infants' looks were significantly greater after the barking events compared to before only when the experimenter was attending to them. These results suggest that by 10 months infants monitor and refer to people in an ambiguous situation depending on their attention toward them. This development is viewed as indexing the emergence of an intentional stance in social referencing by 10 months of age.

The way in which infants look at people changes dramatically over the course of the first year, coinciding with emerging social competencies (e.g., Rochat & Striano, 1999). Early looking patterns in social contexts are generally characterized as dyadic, with the infants' attentional focus remaining exclusively on a social partner during face-to-face interaction. However, toward the end of the first year looking behavior becomes increasingly referential, or coordinated between people and objects. Interest in the emergence of referential looking is widespread as this simple

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behavioral manifestation is considered a major milestone of infants' social cognitive capacities indexing a primitive understanding that people have intentions directed to the outside world. Such intentional stance taken by infants is a basic underpinning of theories of mind emerging by the third year (Baron-Cohen, 1995; Hala, 1997; Tomasello, 1995; Wellman, 1993).

Infants' referential looking radiates across much of their behavioral repertoire by the end of the first year. For instance, infants start to follow people's gaze or gesture in relation to external events and situations (Carpenter, Nagell, & Tomasello, 1998; Corkum & Moore, 1998), to look to others in the context of joint play (Bakeman & Adamson, 1984; Carpenter et al., 1998), and to check their emotional perspective to disambiguate a novel situation (Campos & Sternberg, 1981; Sorce, Emde, Campos, & Klinnert, 1985; Walden & Ogan, 1988).

Two opposing viewpoints are commonly cited to account for the manifestation of referential looking. The traditional, "rich," interpretation is that the ability of infants to engage in referential looking across a variety of contexts presupposes a rudimentary insight into others' minds. The idea is that infants seek and interpret others' focus of attention and corresponding emotional perspective because they appreciate that people have emotions, intentions, and perspectives that differ from their own (Bretherton, 1991; Striano & Rochat, 1999; Tomasello, 1995; Wellman, 1993). An alternative view to the putative intentional stance taken by infants is that referential looking behaviors could be accounted for by the process of associative learning and the general development of attention (Corkum & Moore, 1995, 1998; Perner, 1991; Ruff & Rothbart, 1997), particularly the development of attention to faces (e.g., Fantz, 1963; Johnson, Dziurawiek, Ellis, & Morton, 1991; Walton, Bower, & Bower, 1992). Accordingly, the "lean interpretation" is that referential looking behaviors might emerge from an early attunement to faces that is reinforced without any deep social cognitive understanding of others' intentions *per se*.

There is no contention that by the end of the first year infants become increasingly involved in referential looking, coordinating attention between people, objects, and events. However, questions remain regarding the meaning of such behavior, namely, whether it implies a rudimentary understanding of others' intention or whether it can be explained by associative learning. In addition, little is known regarding the developmental origins of referential looking because the majority of research has considered the meaning of such behavior in infants 9 months and older, when these behaviors are already in place (e.g., Baldwin & Moses, 1994; Carpenter et al., 1998; Hornick, Risenhoover, & Gunnar, 1987).

This study was designed to address such questions. We devised an experiment to test the extent to which 7- and 10-month-old infants refer to others on the basis of an understanding of their attentional state (behavioral cue to their intention) in relation to them. We chose these ages based on previous research suggesting some increase in referential looking behavior between 7 and 10 months (Striano & Rochat, 1999). In Study 1, we compared 7- and 10-month-olds' gazing behavior

toward an adult stranger who either attended or did not attend to them as they encountered a series of events (i.e., the barking of a toy remote-controlled dog). In Study 2, we assessed the relative role of visual attention versus contingent vocal feedback as a determinant of 10-month-olds' referential looking.

We predicted that with an emerging intentional stance, infants would selectively look to the stranger when visually attentive to them (either to disambiguate the situation or to share the cardinal events). We also expected that they would socially refer to the stranger more following the events compared to before such events occurred.

STUDY 1

Method

Participants. A total of 42 infants (19 boys and 23 girls) were included in the final sample: twenty-four 7-month-olds ($M = 7$ months, 17 days; range = 6 months, 28 days–7 months, 29 days) and eighteen 10-month-olds ($M = 10$ months, 14 days; range = 9 months, 25 days–10 months, 30 days). Eighty percent of the infants were from White middle-class families, and 20% were from African-American middle-class families. An additional 28 infants (eight 7-month-olds and nineteen 10-month-olds) were excluded due to fussiness. Infants were excluded if they cried excessively for 30 sec or more during any part of the study. Parents of infants participated on a voluntary basis. Infants were part of the Emory Laboratory Infant Subject Pool recruited from North Atlanta Maternity Hospital in Atlanta. All infants were full-term (> 38 weeks gestational age) with Apgar scores between 8 and 10 and a birth weight of 2,500 g or more. No health problems were reported at the time of testing and on the medical chart consulted at the time of delivery.

Setup and apparatus. Infants were videotaped while interacting with a female adult stranger sitting across from them approximately 2.5 ft away at eye level. Infants were placed in a commercial high chair (Graco) with an attached tray. A small wooden stool (3 ft high) with a book on the top was placed on the right side of the infant approximately 1.5 ft away, and out of infants' reach.

The experimenter and infant were videotaped via two synchronized cameras. Both images were mixed and recorded via a video-splitter (Robot mode MV45). A zoom-lens video camera placed on a tripod behind the experimenter (Panasonic AG-186) recorded a frontal view of the infant's face including upper body. A small camera (Panasonic WV-BL200) was placed on a tripod approximately 6 ft to the side of the experimental setup, providing a right side view of the infant and experimenter. A video-timer (Burst Electronics TC-3 SMPTE) was superimposed onto the recorded image of the infant for later coding.

A curtain hung from the ceiling provided a homogeneous background to prevent any visual distraction. A second experimenter stood behind the curtain to time the interaction with a stopwatch and monitor the interaction over a TV monitor. Parent(s) watched their infant from the monitor as well, remaining out of sight and silent.

Design and procedure. At the start of the experiment, the experimenter interacted playfully (cheerful greetings) with the infant for approximately 5 sec. The experimenter then removed a toy remote-controlled dog from under the infant chair, placing it on the high-chair table tray for 3 min. The dog barked for 2 sec at 30-sec intervals via a remote control held beneath the table tray and controlled by the experimenter. Because the first experimenter was aware of the study's hypotheses, the second experimenter cued the first experimenter when to activate the dog by raising one hand strictly every 30 sec. The first sound occurred 30 sec into the testing, and the toy was activated a total of six times for 2 sec over the 3-min testing time.

Each infant participated in one of two conditions: In a look toward condition, the experimenter looked silently toward the infant's face throughout the session. To avoid inducing gazing or smiling responses from the infant, only after the infant spontaneously looked up to the experimenter's face, the experimenter responded with a simple "Yes!" or "Wow!" In a look away condition, the experimenter was turned approximately 45° sideways relative to the infant, reading a book. In this condition, the experimenter did not respond to any gaze of the infant.

Coding and reliability. Based on video recordings, the percentage of total time for the following behaviors and events were coded:

- Gaze to experimenter: Infant looks to the experimenter's face.
- Gaze to dog: Infant looks to the toy dog.
- Gaze to book: Infant looks toward the book.
- Toy dog activated: Toy dog makes barking sound.

Videotapes were scored simultaneously by two naive observers using a computerized event recorder. While viewing the online video recording of the infant and pressing a particular key on a computer corresponding to a specific behavior, the observers activated the channels of the event recorder. Each observer simultaneously activated two channels. Using computerized printouts of the time sequence of these measures, a third individual calculated the duration of infant's individual looking bouts for the 10 sec prior to and after each barking dog event. The duration of infant's individual looking bouts to the experimenter was measured with a ruler from time printouts and directly converted into seconds (1 cm = 1 sec real time).

For reliability, the two original naive observers coded videotapes for the two measures they had not initially coded. Reliabilities were performed for 20% of infants at each age group and condition. Coders were naive regarding the predictions of the study. However, they were aware of the experimental condition because the experimenter's head was in view of the video image. Cohen's kappa coefficient was above .87 for all infants and measures.

Results

Overall gazing. We first present results pertaining to the overall percentage of gazing at the experimenter. A 2 (Age: 7-month-olds vs. 10-month-olds) \times 2 (Condition: look toward vs. look away) between-group analysis of variance (ANOVA) on the proportion of time infants spent gazing at the experimenter yielded a marginally significant effect of condition, $F(1, 41) = 3.48, p < .07$. Overall, regardless of age, infants tended to gaze at the experimenter proportionally more in the look toward ($M = 22.65\%$ of the time) compared to the look away condition ($M = 15.07\%$ of the time). No other significant main effects or interactions were found. Analysis of the proportion of time infants spent gazing at the book or the toy dog yielded no main effects or any interactions.

We further compared infants' looking responses during the 10-sec period that immediately preceded barking (prior to bark) with looking responses that followed barking, consisting of the 2-sec period during the bark and the 8 subsequent sec (after bark).

Duration of gazing toward the experimenter prior to and after barking episodes. A 2 (Age: 7-month-olds vs. 10-month-olds) \times 2 (Condition: look toward vs. look away) \times 2 (Period: prior to bark vs. after bark) mixed design ANOVA on the average duration of looking toward the experimenter yielded no significant main effects of age or condition. There was a significant main effect of period, $F(1, 38) = 5.96, p < .02$, indicating that the duration of infants' gazing toward the experimenter was greater in the after bark compared to the prior to bark period. Furthermore, there was a significant Age \times Condition \times Period interaction, $F(1, 38) = 4.64, p < .03$. Simple effects revealed only a significant main effect of period for the group of 7-month-olds, $F(1, 22) = 5.65, p < .03$. As shown in the top of Figure 1, they displayed more looking toward the experimenter after bark episodes compared to prior periods, regardless of condition. In contrast, the ANOVA yielded a significant Condition \times Period interaction for the 10-month-olds, $F(1, 16) = 4.80, p < .04$, who displayed more looking toward the experimenter in the after bark period for the look toward condition only, $F(1, 11) = 9.24, p < .01$. This significant interaction is illustrated in the bottom panel of Figure 1.

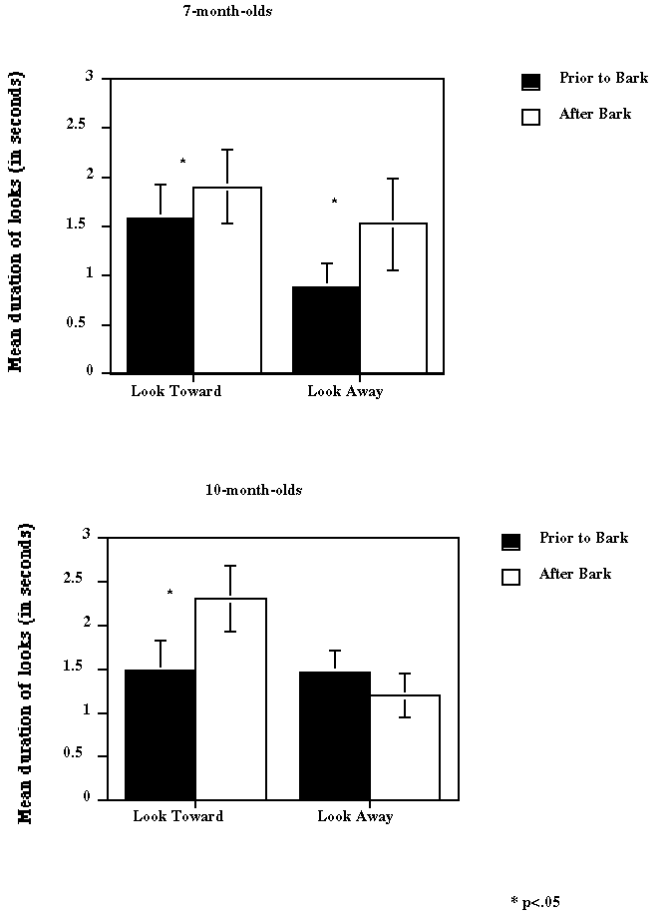


FIGURE 1 Average duration of looks to the experimenter for 7-month-olds (top panel) and 10-month-olds (bottom panel) as a function of condition and time period.

Discussion

The 7-month-olds' looking bouts were significantly greater after the dog barking episodes compared to prior, regardless of experimental condition. In contrast, for the 10-month-olds the duration of their looking bouts toward the experimenter was significantly greater after the dog barking episodes compared to prior in the look toward condition, but not in the look away condition.

These findings suggest that by 10 months infants monitor the attention of others in relation to their own. Substantiating this finding, a disproportionate number of

10-month-olds tested were excluded from the look away condition because they fussed excessively (68% of 10-month-olds excluded from look away condition vs. 33% excluded from the look toward condition), suggesting that by the end of the first year infants start to consider the perspective of others, noticing and responding when people are not available to offer emotional cues or share visual attention. However, further controls are needed to interpret these findings. In the preceding experiment, only in the look toward condition, and following a spontaneous look of the infant toward the experimenter, the latter provided verbal feedback (i.e., “Yes!” or “Wow!”; see Method section). In the look away condition, the experimenter remained silent. It is therefore possible those infants who showed the phenomenon were responding to the experimenter’s verbal feedback during the look toward condition, independently of any attention monitoring, hence any intentional stance.

To control for this possibility, in Study 2 we tested an additional group of 10-month-olds (age at which infants showed differential social referencing depending on condition) in the look away condition with the addition of verbal feedback. We compared this new group to the group of 10-month-olds in Study 1 tested in the look toward condition. In other words, we compared two groups of 10-month-olds, each group tested in one condition where the experimenter either looked toward or away from them. The experimenter in both conditions provided contingent verbal feedback when the infant spontaneously looked up to the face.

We predicted that 10-month-olds would continue to look toward the experimenter’s face depending on the experimenter’s visual attention toward them, engaging in significantly less referencing in the look away condition, even when the experimenter provided contingent verbal feedback.

STUDY 2

Method

Participants. Twenty-four 10-month-old infants were included in the final sample. This included twelve of the 10-month-old infants (5 boys and 7 girls) from the look toward condition of Study 1 ($M = 10$ months, 14 days; range = 9 months, 25 days–10 months, 30 days) and a new group of twelve 10-month-old infants (6 boys and 6 girls; $M = 10$ months, 19 days; range = 9 months, 27 days–11 months, 0 days). An additional 4 infants were tested but not included in the final sample (2 because of equipment failure, 1 because of mother interference, and 1 because of fussiness). All characteristics of the new sample were the same as in Study 1.

Setup and apparatus. Infants were videotaped while interacting with a female adult stranger sitting across from them approximately 2.5 ft away at eye level,

with a small 3.5-ft-high table placed between them. To prevent infants from becoming distressed as they did in the look away condition of Study 1, they sat on their mother's lap facing the experimenter. Mothers wore a pair of opaque sunglasses and were instructed to remain silent, lean back on their chair, and hold their infant steadily on their lap. Infants generally did not turn to look at their mother (less than 4% of all looks were to their mother). The apparatus was the same as in Study 1. In addition, a television monitor connected to the camera recording the infant was placed immediately behind and adjacent to the stool so that the experimenter could monitor the infant while looking away. A piece of white foamboard was attached to the sides of the monitor so that infants could not see the image.

Design and procedure. The procedure was the same as in Study 1 except that the experimenter turned the head and eyes approximately 45° appearing to be looking away at the book, but actually monitoring surreptitiously the online image of the infant. Each time the infant looked at the experimenter's face, the experimenter responded by saying "Wow!" or "Yes!" while patting the dog for approximately 1 to 2 sec. The rationale for adding the contingent patting gesture was to accentuate social contingency on the part of the experimenter, hence enhancing possible associative learning.

Coding and reliability. The procedure for coding and reliability was the same as in Study 1. Cohen's kappa coefficient was above .90 for all infants and measures.

Results

As in Study 1, we compared infants' looking responses during the 10-sec period that immediately preceded barking (prior to bark) with looking responses that followed barking, consisting of the 2-sec period during the bark and the 8 subsequent sec (after bark). The new sample of infants is that included in the present look away contingent condition. We compared them to the 10-month-olds in the look toward condition of Study 1.

Duration of gazing toward the experimenter prior to and after barking episodes. A 2 (Condition: look toward vs. look away contingent) \times 2 (Period: prior to bark vs. after bark) mixed design ANOVA on the average duration of looking bouts toward the experimenter yielded a significant main effect of period, $F(1, 22) = 10.42, p < .004$ with the duration of looking bouts toward the experimenter greater in the period after barking episodes compared to immediately prior. The ANOVA also yielded a significant Condition \times Period interaction, $F(1, 22) = 4.2, p < .05$. As shown in Figure 2, simple effects indicated a significant period effect for

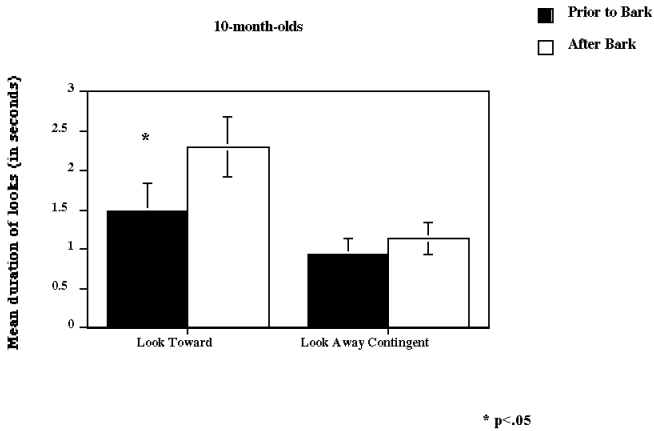


FIGURE 2 Average duration of looks to the experimenter for 10-month-olds as a function of condition and time period.

the look toward condition only, $F(1, 11) = 9.24, p < .01$). The duration of infants' looks toward the experimenter was significantly greater in the period after the barking events in the look toward condition only.

GENERAL DISCUSSION

The aim of this research was to address the meaning and developmental emergence of infants' referential looking behaviors. In Study 1, we considered 7- and 10-month-old infants' looking behavior toward an adult stranger who was either socially engaged or nonengaged as they were presented with a novel and animated toy. We found that infants at both ages tended to look up to the experimenter following the bark of the mechanical dog, but only 10-month-olds demonstrated differential looking toward the experimenter depending on the focus of the experimenter's attention. In the look away condition, 10-month-olds tended to look significantly less toward the experimenter. By this age, infants show selective social referencing as a function of an adult's attention, hence the communicative intent of the social partner.

In Study 2, we confirmed these observations with the 10-month-olds, controlling for factors other than communicative intent specified by the presence or absence of eye contact. In the look toward and look away conditions, the experimenter was equally contingent motorically and verbally, patting the dog and cheering each time the infant looked to the face. This converging evidence sup-

ports the interpretation that by 10 months, infants are discriminant in their social referencing depending on the gaze direction of the social partner. Gaze direction in relation to the self appears to be the basis for 10-month-old infants to detect communicative intentions in others. By this age, and not earlier, this detection starts to determine infants' willingness to refer socially in the face of novel, ambiguous events in their environment.

Overall, this research clearly demonstrated important development between 7 and 10 months in the meaning of referential looking patterns. In contrast to the older group, 7-month-olds did refer to the experimenter by looking up toward the face after the barking event, regardless of whether the experimenter was visually engaged or not. This pattern of behavior is probably determined by the overall search for cues in the social partner to disambiguate novel events. Although a necessary precursor to an emerging intentional stance, such referencing does not rest on any understanding that cues from the social partner depend on shared attention. In this sense, if infants socially refer it is in the broad sense of monitoring others' face, and would imply a sensitivity to gaze direction but not necessarily an appreciation of the referential nature of others' gaze (see Tomasello, 1995). Such broad (unselective) social referencing is probably part of the early propensity of infants to attend to faces, preferring to look from birth at faces over other objects (Fantz, 1963; Haith, Bergman, & Moore, 1977), and eye contact becoming at least from 2 months of age an intrinsic part of infants' calming system (Blass, 1999; Zeifman, Delaney, & Blass, 1996). This interpretation also fits the view that early looking toward others in novel situations is the result of emotional contagion and even mere conditioning, rather than based on any understanding of others' intentions (Perner, 1991; Weinger & Anisfeld, 1998). Based on the observations collected with 7-month-olds, there is no clear evidence that an intentional stance underlies infants' looking toward the experimenter.

In contrast, what we found with the 10-month-olds cannot be reduced to the preceding (lean) interpretation. Infants show selectivity in their social referencing depending on the attention (intention) of the social partner toward or away from them. This finding strongly suggests that an intentional stance underlies 10-month-old infants' referential looking patterns.

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REFERENCES

- Bakeman, R., & Adamson, L. (1984). Coordinating attention to people and objects in mother–infant and peer–infant interactions. *Child Development*, *55*, 1278–1289.
- Baldwin, D. A., & Moses, L. J. (1994). Early understanding of referential intent and attentional focus? Evidence from language and emotion. In C. Lewis & P. Mitchell (Eds.), *Children's early understanding of mind: Origins and development* (pp. 133–156). Hove, England: Lawrence Erlbaum Associates, Ltd.
- Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind*. Cambridge, MA: MIT Press.
- Blass, E. (1999). The ontogeny of human infant face recognition: Orogustatory, visual and social influences. In P. Rochat (Ed.), *Early social cognition* (pp. 35–67). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Bretherton, I. (1991). Intentional communication and the development of an understanding of mind. In D. Frye & C. Moore (Eds.), *Children's theories of mind: Mental states and social understanding* (pp. 49–75). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Campos, J., & Sternberg, C. (1981). Perception, appraisal, and emotion: The onset of social referencing. In M. Lamb & L. Sherrod (Eds.), *Infant social cognition: Empirical and theoretical considerations* (pp. 273–314). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence. *Monographs of the Society of Research in Child Development*, *63*(4, Serial No. 255).
- Corkum, V., & Moore, C. (1995). Development of joint visual attention in infants. In C. Moore & P. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 61–83). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Corkum, V., & Moore, C. (1998). Origins of joint visual attention in infants. *Developmental Psychology*, *34*, 28–38.
- Fantz, R. L. (1963). Pattern vision in newborn infants. *Science*, *140*, 296–297.
- Haith, M., Bergman, T., & Moore, M. (1977). Eye contact and face scanning in early infancy. *Science*, *198*, 853–855.
- Hala, S. (1997). *The development of social cognition*. Hove, England: Psychology Press.
- Hornick, R., Risenhoover, N., & Gunnar, M. (1987). The effects of maternal positive, neutral, and negative affective communications on infant responses to new toys. *Child Development*, *58*, 937–944.
- Johnson, M. J., Dziurawiec, S., Ellis, H., & Morton, J. (1991). Newborns' preferential tracking of face-like stimuli and its subsequent decline. *Cognition*, *40*, 1–19.
- Perner, J. (1991). *Understanding the representational mind*. Cambridge, MA: MIT Press.
- Rochat, P., & Striano, T. (1999). Social cognitive development in the first year. In P. Rochat (Ed.), *Early social cognition* (pp. 3–35). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Ruff, H., & Rothbart, M. (1997). *Attention in early development: Themes and variations*. New York: Oxford University Press.
- Sorce, J., Emde, R. N., Campos, J. J., & Klinnert, M. D. (1985). Maternal emotional signaling: Its effect on the visual cliff behavior of one-year-olds. *Developmental Psychology*, *21*, 185–200.
- Striano, T., & Rochat, P. (1999). Relation between dyadic and triadic social competence in 7- to 10-month-old infants. *British Journal of Developmental Psychology*, *17*, 551–562.
- Tomasello, M. (1995). Joint attention as social cognition. In C. Moore & P. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 103–130). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Walden, T., & Ogan, T. (1988). The development of social referencing. *Child Development*, *59*, 1230–1240.
- Walton, G. E., Bower, N. J., & Bower, T. G. R. (1992). Recognition of familiar faces by newborns. *Infant Behavior and Development*, *15*, 265–269.

- Weinger, H., & Anisfeld, M. (1998, April). *A meta-analytic review of social referencing*. Poster session presented at the biennial meeting of the International Society of Infant Studies, Atlanta, GA.
- Wellman, H. (1993). Early understanding of mind: The normal case. In S. Baron-Cohen, H. Tager-Flusberg, & D. Cohen (Eds.), *Understanding other minds* (pp. 10–39). Oxford, England: Oxford University Press.
- Zeifman, D., Delaney, S., & Blass, E. M. (1996). Sweet taste, looking and calm in 2- and 4-week-old infants: The eyes have it. *Developmental Psychology*, *32*, 1090–1099.

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