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On Privileging the Role of Gaze in Infant Social Cognition

Nameera Akhtar¹ and Morton Ann Gernsbacher²

¹University of California, Santa Cruz

²University of Wisconsin–Madison

Abstract

Theories of early social-cognitive development privilege infants' use of gaze as a cue to others' attention and intentions. Mutual gaze is assumed to indicate social engagement, gaze following is believed to index understanding of others' attention, and gaze alternation (between an object and a caregiver) is used to assess joint attention. This article discusses other cues (e.g., vocal and postural) on which children in other cultures and atypically developing children in Western cultures probably rely. It proposes that it is quite likely that typically developing children in Western cultures also use nongaze cues—in conjunction with gaze—in their everyday interactions with others.

A great deal of recent research has focused on the role of gaze in the development of infants' social understanding (e.g., Flom, Lee, & Muir, 2007). Gaze probably plays a significant role in the social and social-cognitive development of Western, middle-class, typically developing, sighted infants. However, studies of other communities and of infants developing atypically suggest that other behaviors may play a similar role. In this article, we call attention to neglected aspects of infants' sensory experience that most likely also contribute to their social and social-cognitive development. We also explore the possibility that for some infants, these other modalities may be paramount.

We organize our review around three gaze-based behaviors—mutual gaze, gaze following, and gaze alternation—each of which has been used to assess or represent an important construct in social or social-cognitive development. Mutual gaze is used as an indicator of social engagement, gaze following is believed to index understanding of others' attention or intentions, and gaze alternation (between an object and a caregiver) is used to assess joint attention between infant and caregiver. For each of these behaviors, we begin by describing the role it is assumed to play in typically developing infants in Western societies. We then examine the use of the behavior in atypical development and in non-Western cultures. We consider whether nongaze behaviors may serve the same function; for example, in communities in which mutual gaze is less frequent than in the Western middle-class context, continuous physical contact between infant and caregiver may serve the function of engagement. We conclude by recommending that researchers pay attention to mechanisms

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Correspondence concerning this article should be addressed to Nameera Akhtar, Psychology Department, University of California, Santa Cruz, 1156 High Street, Santa Cruz, CA 95064, nakhtar@ucsc.edu.

other than gaze, as these other mechanisms probably play an important role in the social-cognitive development of all infants.

Mutual Gaze

Mutual gaze between infants and caregivers is taken as evidence of mutual engagement and is argued to signal to infants their caregivers' pedagogical intent (Csibra & Gergely, 2006; Gergely, Egyed, & Kiraly, 2007). Newborns orient to and spend more time looking at photos of faces that appear to be looking directly at them than at identical photos with eyes averted (Farroni, Csibra, Simion, & Johnson, 2002). Although this finding is often interpreted as an innate preference for mutual gaze, this preference was found in a static, noninteractive context. In live interactive situations, infants' preference for eye contact is more complex.

For example, mutual gaze between infant and caregiver (in conjunction with sucrose) calms infants who are distressed (Blass, Lumeng, & Patil, 2007). However, when infants are overaroused (manifested by heart rate accelerations), they actively avert gaze from their caregivers, leading to significant heart rate decelerations (Field, 1981). Thus, gaze aversion can be self-calming in certain contexts. And, in some contexts, avoiding eye contact may be beneficial. For example, adults avert their gaze when answering complex questions or solving challenging problems (Glenberg, Schroeder, & Robertson, 1998), and when 5-year-olds are trained to avert their gaze during cognitively demanding tasks, their performance improves (Phelps, Doherty-Sneddon, & Warnock, 2006). Because maintaining mutual gaze consumes processing resources, gaze aversion serves the adaptive function of managing cognitive load (Doherty-Sneddon & Phelps, 2005, 2007).

Compared with Boston mothers, Gusii mothers in Kenya engage in more touching and holding and less eye contact and talking (Richman, Miller, & LeVine, 1992). The difference is quite pronounced: In one study, only 1% of Gusii mothers' acts toward their 9- to 10-month-old infants involved looking, in contrast to 43% of the Boston mothers' acts toward their infants (LeVine et al., 1994). Moreover, Gusii mothers tend to look away when their infants get excited (Dixon, Tronick, Keefer, & Brazelton, 1981), suggesting that they use gaze aversion as a calming technique. Gusii mothers also respond more frequently and quickly to their infants' distress, practice cosleeping, and breastfeed on demand. LeVine (2004, p. 161) has proposed that these other behaviors "could be functionally equivalent to the verbal and visual engagement of Americans" and suggests "we should be investigating the possibility of alternative forms of engagement." We could not agree more. Furthermore, such constant physical contact most likely increases olfactory input, and exposure to maternal and familiar odors has been found to be soothing to infants (Goubet, Rattaz, Pierrat, Bullinger, & Lequien, 2003; Sullivan & Toubas, 1998).

Because infants tend to be most responsive to the contingencies they experience in daily interactions with their caregivers (Bigelow, 1998; Bigelow & Birch, 1999; Bigelow & Rochat, 2006), it is possible that infants who experience continuous physical or vocal contact with their caregivers rely on tactile, auditory, and olfactory cues more than eye contact as evidence of engagement. Certainly, blind children rely on nonvisual modalities to

maintain engagement with others (Mulford, 1983), and it is likely that other atypically developing children do as well. For example, gaze aversion is a common characteristic of autistic children (Gernsbacher & Frymiare, 2005) that is often interpreted as indicating a lack of engagement. However, it is possible that autistic children use other modalities to maintain engagement with their caregivers (Gernsbacher, 2006; Gernsbacher, Stevenson, Khandakar, & Goldsmith, 2008a, 2008b).

Another reason to be cautious about privileging mutual gaze as a marker of social engagement is that cultures differ in how their infants are typically held and carried. For example, in Papua New Guinea, Kaluli mothers hold their infants outward, either in the mother's arms or on her shoulders, rather than face-to-face. Ochs and Schieffelin (1984, p. 279) observed that Kaluli mothers and infants "do not gaze into each other's eyes, an interactional pattern that is consistent with [Kaluli] adult patterns of not gazing when vocalizing in interaction with one another." Similarly, Palestinian families tend to spend more time than Israeli families holding infants on their laps rather than in face-to-face positions; thus, less mutual gaze occurs in Palestinian than in Israeli families (Feldman, Masalha, & Alony, 2006). Even in Western middle-class families, when infants are in face-to-face positions, they spend more time looking away from their caregivers' faces when they are held upright than when they are cradled or lying down (Fogel, Messinger, Dickson, & Hsu, 1999). Thus, how infants are typically held affects the relative amount of eye contact they experience, suggesting that physical contact might play the same role as eye contact in social engagement.

Indeed, touch is known to play a very important role in early social interactions (Field, 2003; Stack, 2001). The still-face paradigm, in which parents abruptly cease interacting with their infants for a short period of time and their infants' reactions are measured, temporarily deprives infants of visual and auditory interactive input (facial expressions, talking, and eye contact) from their caregivers. Negative effects of the still face are attenuated (i.e., infants smile more and grimace less) if parents continue to touch their infants while maintaining the still face (Stack & Muir, 1990, 1992). Thus, touch probably signals to infants that their caregiver is still engaged with them, even if not visually responsive, and Stack and her colleagues have shown that it is not the mere presence versus absence of touch that is important; rather, it is the quality of touch (Stack & Arnold, 1998; Stack & LePage, 1996). In sum, lack of eye contact does not imply lack of social engagement; tactile and vocal contact may be as important as eye contact in maintaining social interactions with infants.

Gaze Following

Many experimental studies have demonstrated that 1-year-olds can follow an adult's gaze to locate an interesting object, and somewhat older infants can use gaze to determine which of two objects an adult is labeling (Baldwin, 1993a, 1993b). At 1 year, infants are beginning to understand that gaze connects the looker to the object being looked at (Woodward, 2003), and they use gaze cues (along with emotion cues) to predict what someone is going to do next (Phillips, Wellman, & Spelke, 2002). Early gaze following is therefore seen as leading to an understanding of others as holding intentional relations to objects, an understanding that may play a critical role in word learning (at least the learning of object labels).

Indeed, recent studies demonstrate that gaze following ability in typically developing 10- to 11-month-old infants predicts their subsequent vocabulary development (Brooks & Meltzoff, 2005, 2008). Gaze following is also interpreted as the ability to represent what another person can and cannot see (Moll & Tomasello, 2004), and this ability is seen as a precursor to theory of mind (Charman et al., 2000; Sodian, Thoermer, & Metz, 2007).

It is important to note, however, that in naturalistic interactions, changes in gaze direction are almost always accompanied by changes in body posture, head orientation, and voice direction—all of which redundantly specify the same referent (Kita, 2003; Sabbagh, Henderson, & Baldwin, 2007; see also Bahrick, Lickliter, & Flom, 2004). In some studies, these aspects are separated, but in others, they are not, with the results still described as infants following gaze. As Vaughn Van Hecke and Mundy (2007, p. 40) have pointed out, it may be the “integrated processing of others' direction of gaze, limb/postural directions, and vocal behavior,” rather than gaze direction per se, that provides the information that is crucial to learning about others' focus of attention. Infants may use various body movements in combination with gaze and voice direction as in essence deictic gestures that indicate another's attentional focus (Chen, Ballard, & Aslin, 2005).

Posture, touch, and vocal cues are often overlooked as potential cues to intentions, but they play important roles in communication with infants. To our knowledge, infants' use of postural cues to intent has not been studied systematically, but we know that adults use posture to infer emotions and cultures differ in the specific postural features used (Kleinsmith, DeSilva, & Bianchi-Berthouze, 2006). When infants are held, they adjust to the movements of the person holding them, and ethnographic and observational studies suggest that infants who experience multiple postural adjustments by their caregivers come to anticipate the caregivers' subsequent posture (Bril & Sabatier, 1986). Caregiver posture may serve a similar deictic function as pointing and looking because leaning toward something may signify interest in or reference to that thing (Mumme, Bushnell, DiCorcia, & Lariviere, 2007). Infants may be sensitive to posture changes even earlier than gaze direction; Meltzoff and Brooks (2007, p. 227) suggest that young infants “understand others as ‘body orienters’” before they understand the significance of the eyes for perception.

Because of cultural differences in how infants tend to be held (see Mutual Gaze section), we should expect cultural differences in the cues infants use to ascertain their caregivers' attention and intentions. We speculate that in cultures in which babies are frequently held on their caregivers' laps or backs, infants are likely more attuned to their caregivers' postural positions than to their caregivers' gaze direction. Infants also monitor the gaze (and posture) of people who are not interacting with them (deLeon, 1998; Rogoff, Paradise, Mejia Arauz, Correa-Chavez, & Angelillo, 2003).

Touch may also provide cues to caregivers' intentions. It is the first sense to develop in infancy (Field, 2003), and it plays an important role in emotion regulation (Hertenstein & Campos, 2001; Hertenstein, Verkamp, Kerestes, & Holmes, 2006). Because “a particular touch can vary in its action (e.g., stroking, rubbing, squeezing), intensity, velocity, abruptness, temperature, location, frequency, duration, and extent of surface area touched” (Hertenstein, 2002, p. 74), measuring touch is complicated. But qualitatively different types

of touch may communicate discrete emotions (Hertenstein, 2002). It is also possible that a caregiver's "action readiness may be specified by the contraction of particular muscle groups ... [which may] help the infant predict what the caregiver is going to do" (Hertenstein, 2002, p. 75). Research is needed to test these specific hypotheses.

Although vision is clearly important for deaf infants learning a signed language, tactile communication is also critical (Koester, Brooks, & Traci, 2000; Meadow-Orlans, Spencer, & Koester, 2004). For deaf mother–infant dyads, touch plays a role in "eliciting visual attention, in alerting the infant that signed communication is forthcoming, or in simply maintaining contact even when one partner has looked away" (Koester et al., 2000, p. 129). The "tap/sign" strategy used by deaf parents—tapping on the infant's body before signing in his or her visual field—serves not only as an attention-getter but also as a signal that intentional communication is forthcoming (Waxman & Spencer, 1997).

Vocal cues are important in early communication because hearing infants can experience them when parents are out of sight (e.g., in another room). In cultures in which infants spend a lot of time carried on their caregivers' backs, vocal cues (e.g., voice direction, prosody) may be particularly important relative to gaze (Baldwin & Moses, 1996; Fernald, 1993). Even in Western contexts, vocal cues may be as important as, if not more important than, facial cues in conveying emotional information to infants, as demonstrated by the social referencing paradigm (Mumme, Fernald, & Herrera, 1996; Vaish & Striano, 2004).

Vocal and other auditory cues are of course crucial for blind children. Bigelow (2003, p. 271) has noted that to determine where objects and people are located, "blind children depend on tactile and kinesthetic information and memory, sound changes, air currents, and echolocation ... as well as the verbal comments of others," and to determine the attentional focus of others they rely on auditory and tactile information. Interestingly, blind children's earliest words label their experiences of touch, taste, and smell (Bigelow, 1987).

In sum, gaze direction is only one of several potential cues to another's focus of attention. Given that these cues are often redundant, that it is well known that attention is not just where the eyes are focused (Posner, Snyder, & Davidson, 1980), and that infants' opportunities to monitor their caregivers' gaze vary by culture, it is perhaps premature to consider gaze the primary cue infants that use to determine others' focus of attention. Similarly, it is probably premature to consider gaze following the primary metric of infants' understanding of others' intentions.

Gaze Alternation

Alternating gaze at an object with gaze at a caregiver has been used to operationalize joint attention between infant and caregiver (Kasari, Freeman, & Paparella, 2006). Simply gazing at the same referent as the caregiver is not considered evidence of joint attention; the infant must also alternate his or her gaze to the object with gaze to the caregiver's face (Carpenter, Nagell, & Tomasello, 1998; Lord et al., 2000; Mundy et al., 2007). For example, the only indicator that a child has initiated joint attention according to the Autism Diagnostic Observation Schedule requires that the child "uses clearly integrated eye contact to reference

an object that is out of reach by looking at the object, [looking back] at the examiner, and [looking] back to the object” (Lord et al., 2000).

Given our discussion thus far, it should not be surprising that we recommend against assuming that gaze alternation is the only, or even the best, means of signaling shared reference. First, looks to a caregiver's face do not necessarily imply “sharing” attention (Moore, 1998). As many researchers have noted, faces are attractive to infants, and there can be many reasons why infants might look at their caregivers' face after looking at objects; they might be looking for comfort or for information or for both (Striano & Vaish, 2006; Striano, Vaish, & Benigno, 2006). Indeed, many laboratory assays of joint attention employ ambiguous stimuli (e.g., “mechanical toys, designed to provoke a mixture of attraction and uncertainty in the child”; Charman et al., 1997, p. 784) similar to the stimuli used in social referencing paradigms.

Second, adults and infants can jointly attend to things they are not looking at (Akhtar & Gernsbacher, 2007); that is, other sensory modalities—touch, posture, vocal, and auditory cues—can also serve the function of signaling shared reference. For example, a child sitting in her mother's lap while they both handle a toy would likely sense from her mother's posture and touch that they are jointly attending to the toy.

Third, as with mutual gaze and gaze following, there are cultural differences in infants' use of gaze alternation. For example, in Nigeria, Ngas-speaking toddlers are very unlikely to alternate gaze between a novel attention-attracting toy and an adult's face in a structured joint-attention task (Childers, Vaughan, & Burquest, 2007). Moreover, given the research we reviewed previously about the adaptive role of gaze aversion during uncertainty, alternation of object gaze with averted, not mutual, gaze might be a more adaptive response in some contexts. At the least, sustained gaze on the object might be warranted. Indeed, chronometric attention studies (Frischen & Tipper, 2004) document that gaze alternation may result in cognitive interference not facilitation.

In sum, given cultural differences in the value and frequency of mutual gaze and gaze following (and hence their combination), the fact that adults and infants can jointly attend to things at which they are not looking and the likely probability that other sensory modalities—touch, posture, vocal, and auditory cues—also serve the function of signaling shared reference, we recommend against assuming that gaze alternation is the only, or even the best, means of signaling shared attention.

Conclusions

We want to be clear that we are not arguing that gaze is unimportant; rather, we are calling attention to other cues that most likely play a comparable or complementary role in social and social-cognitive development. Thus, our article is an appeal for increased research on the role of other senses and other behaviors that, in addition to and in conjunction with mutual gaze, gaze following, and gaze alternation, allow infants to maintain engagement with others and to construct and demonstrate their intentional understanding of others' behavior.

Because other senses are more difficult to study systematically, especially in laboratory contexts, it is understandable that gaze has been studied more extensively. However, it may be that the relative ease of measuring gaze, along with an ethnocentric bias, has led to an implicit (and sometimes explicit) belief that mutual gaze is the primary means by which infants engage socially with their caregivers, that gaze following is the primary way they learn about others' attention and intentions, and that gaze alternation is the primary behavior by which they demonstrate shared attention.

We would like to emphasize that we do not actually know to what extent infants from other communities and atypically developing infants in Western communities rely on gaze as opposed to the other sensory modalities we have explored in this article. Of course, blind infants must rely on alternate senses, and we have speculated that autistic children and children growing up in different cultural communities may rely on physical contact, posture, and voice cues, but we stress that definitive studies will need to be conducted. To our knowledge, there are no extant studies that systematically compare the use of various modalities to establish and maintain social engagement or to determine another's focus of attention across various populations. At this point, it is unclear whether reliance on alternate modalities to establish engagement and understand intentionality leads to qualitative differences in children's subsequent relationships and social-cognitive skill. Such issues will need to be addressed by longitudinal studies of both typically and atypically developing populations in a variety of cultural groups.

In conclusion, although it is possible that gaze is the primary sense for typically developing, sighted infants in Western middle-class contexts, we cannot assume that gaze is primary without exploring other senses and other populations. By examining variations across cultures and across typical and atypical development, researchers may uncover multiple pathways to achieving social engagement and intentional understanding of others' behaviors.

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References

- Akhtar N, Gernsbacher MA. Joint attention and vocabulary development: A critical look. *Language and Linguistics Compass*. 2007; 1:195–207.
- Bahrick LE, Lickliter R, Flom R. Intersensory redundancy guides the development of selective attention, perception, and cognition in infancy. *Current Directions in Psychological Science*. 2004; 13:99–102.
- Baldwin DA. Early referential understanding: Infants' ability to recognize referential acts for what they are. *Developmental Psychology*. 1993a; 29:832–843.
- Baldwin DA. Infants' ability to consult the speaker for clues to word reference. *Journal of Child Language*. 1993b; 20:395–418. [PubMed: 8376476]
- Baldwin DA, Moses LJ. The ontogeny of social information gathering. *Child Development*. 1996; 67:1915–1939.
- Bigelow AE. Early words of blind children. *Journal of Child Language*. 1987; 14:47–56. [PubMed: 3558525]
- Bigelow AE. Infants' sensitivity to familiar imperfect contingencies in social interaction. *Infant Behavior & Development*. 1998; 21:149–161.

- Bigelow AE. The development of joint attention in blind infants. *Development & Psychopathology*. 2003; 15:259–275. [PubMed: 12931827]
- Bigelow AE, Birch SAJ. The effects of contingency in previous interactions on infants' preference for social partners. *Infant Behavior & Development*. 1999; 22:367–382.
- Bigelow AE, Rochat P. Two-month-old infants' sensitivity to social contingency in mother-infant and stranger-infant interaction. *Infancy*. 2006; 9:313–325.
- Blass, EM.; Lumeng, J.; Patil, N. Influence of mutual gaze on human infant affect. In: Flom, R.; Lee, K.; Muir, D., editors. *Gaze-following: Its development and significance*. Mahwah, NJ: Erlbaum; 2007. p. 113–141.
- Bril B, Sabatier C. The cultural context of motor development: Postural manipulations in the daily life of Bambara babies (Mali). *International Journal of Behavioral Development*. 1986; 9:439–453.
- Brooks R, Meltzoff AN. The development of gaze following and its relation to language. *Developmental Science*. 2005; 8:535–543. [PubMed: 16246245]
- Brooks R, Meltzoff AN. Infant gaze following and pointing predict accelerated vocabulary growth through two years of age: A longitudinal, growth curve modeling study. *Journal of Child Language*. 2008; 35:207–220. [PubMed: 18300435]
- Carpenter M, Nagell K, Tomasello M. Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development*. 1998; 63:176.
- Charman T, Baron-Cohen S, Swettenham J, Baird G, Cox A, Drew A. Testing joint attention, imitation, and play as infancy precursors to language and theory of mind. *Cognitive Development*. 2000; 15:481–498.
- Charman T, Swettenham J, Baron-Cohen S, Cox A, Baird G, Drew A. Infants with autism: An investigation of empathy, pretend play, joint attention, and imitation. *Developmental Psychology*. 1997; 33:781–789. [PubMed: 9300211]
- Chen Y, Ballard DH, Aslin RN. The role of embodied intention in early lexical acquisition. *Cognitive Science*. 2005; 29:961–1005. [PubMed: 21702799]
- Childers JB, Vaughan J, Burquest DA. Joint attention and word learning in Ngas-speaking toddlers in Nigeria. *Journal of Child Language*. 2007; 34:199–225. [PubMed: 17542156]
- Csibra, G.; Gergely, G. Social learning and social cognition: The case for pedagogy. In: Munakata, Y.; Johnson, MH., editors. *Processes of change in brain and cognitive development Attention and performance XXI*. Oxford, England: Oxford University Press; 2006. p. 249–274.
- deLeon L. The emergent participant: Interactive patterns in the socialization of Tzotzil (Mayan) infants. *Journal of Linguistic Anthropology*. 1998; 8:131–161.
- Dixon, SD.; Tronick, EZ.; Keefer, C.; Brazelton, TB. Mother-infant interaction among the Gusii of Kenya. In: Field, TM.; Sostek, AM.; Vietze, P.; Leiderman, PH., editors. *Culture and early interactions*. Hillsdale, NJ: Erlbaum; 1981. p. 149–170.
- Doherty-Sneddon G, Phelps FG. Gaze aversion: A response to cognitive or social difficulty? *Memory & Cognition*. 2005; 33:727–733. [PubMed: 16248336]
- Doherty-Sneddon G, Phelps FG. Teachers' responses to children's eye gaze. *Educational Psychology*. 2007; 27:93–109.
- Farroni T, Csibra G, Simion F, Johnson MH. Eye contact detection in humans from birth. *Proceedings of the National Academy of Sciences*. 2002; 99:9602–9605.
- Feldman R, Masalha S, Alony D. Microregulatory patterns of family interactions: Cultural pathways to toddlers' self-regulation. *Journal of Family Psychology*. 2006; 20:614–623. [PubMed: 17176196]
- Fernald A. Approval and disapproval: Infant responsiveness to vocal affect in familiar and unfamiliar languages. *Child Development*. 1993; 64:657–674. [PubMed: 8339687]
- Field TM. Infant gaze aversion and heart rate during face-to-face interactions. *Infant Behavior & Development*. 1981; 4:307–315.
- Field, T. *Touch*. Cambridge, MA: MIT Press; 2003.
- Flom, R.; Lee, K.; Muir, D. *Gaze-following: Its development and significance*. Mahwah, NJ: Erlbaum; 2007.

- Fogel A, Messinger DS, Dickson KL, Hsu H. Posture and gaze in early mother-infant communication: Synchronization of developmental trajectories. *Developmental Science*. 1999; 2:325–332.
- Frischen A, Tipper SP. Orienting attention via observed gaze shift evokes longer term inhibitory effects: Implications for social interactions, attention, and memory. *Journal of Experimental Psychology: General*. 2004; 133:516–533. [PubMed: 15584804]
- Gergely G, Egyed K, Kiraly I. On pedagogy. *Developmental Science*. 2007; 10:139–146. [PubMed: 17181712]
- Gernsbacher MA. Toward a behavior of reciprocity. *Journal of Developmental Processes*. 2006; 1:139–152.
- Gernsbacher MA, Frymiare J. Does the autistic brain lack core modules? *Journal of Developmental and Learning Disorders*. 2005; 9:3–16.
- Gernsbacher MA, Stevenson JL, Khandakar S, Goldsmith HH. Autistics' atypical joint attention: Policy implications and empirical nuance. *Child Development Perspectives*. 2008a; 2:49–52. [PubMed: 25404951]
- Gernsbacher MA, Stevenson JL, Khandakar S, Goldsmith HH. Why does joint attention look atypical in autism? *Child Development Perspectives*. 2008b; 2:38–45.
- Glenberg AM, Schroeder JL, Robertson DA. Averting the gaze disengages the environment and facilitates remembering. *Memory & Cognition*. 1998; 26:651–658. [PubMed: 9701957]
- Goubet N, Rattaz C, Pierrat V, Bullinger A, Lequien P. Olfactory experience mediates response to pain in preterm newborns. *Developmental Psychobiology*. 2003; 42:171–180. [PubMed: 12555281]
- Hertenstein MJ. Touch: Its communicative functions in infancy. *Human Development*. 2002; 45:70–94.
- Hertenstein MJ, Campos JJ. Emotion regulation via maternal touch. *Infancy*. 2001; 2:549–566.
- Hertenstein MJ, Verkamp JM, Kerestes AM, Holmes RM. The communicative functions of touch in humans, nonhuman primates, and rats: A review and synthesis of the empirical research. *Genetic, Social, and General Psychology Monographs*. 2006; 132:5–94.
- Kasari C, Freeman S, Paparella T. Joint attention and symbolic play in young children with autism: A randomized controlled intervention study. *Journal of Child Psychology and Psychiatry*. 2006; 47:611–620. [PubMed: 16712638]
- Kita, S. Interplay of gaze, hand, torso orientation, and language in pointing. In: Kita, S., editor. *Pointing: Where language, culture and cognition meet*. Mahwah, NJ: Erlbaum; 2003. p. 307-328.
- Kleinsmith A, DeSilva PR, Bianchi-Berthouze N. Cross-cultural differences in recognizing affect from body posture. *Interacting with Computers*. 2006; 18:1371–1389.
- Koester LS, Brooks L, Traci MA. Tactile contact by deaf and hearing mothers during face-to-face interactions with their infants. *Journal of Deaf Studies and Deaf Education*. 2000; 5:127–139. [PubMed: 15454508]
- LeVine, RA. Challenging expert knowledge: Findings from an African study of infant care and development. In: Gielen, UP.; Roopnarine, J., editors. *Childhood and adolescence: Cross-cultural perspectives and applications*. Westport, CT: Praeger; 2004. p. 149-165.
- LeVine, RA.; Dixon, S.; LeVine, S.; Richman, A.; Leiderman, PH.; Keefer, CH., et al. *Child care and culture: Lessons from Africa*. New York: Cambridge University Press; 1994.
- Lord C, Risi S, Lambrecht L, Cook EH Jr, Leventhal BL, DiLavore PC, et al. The Autism Diagnostic Observation Schedule-Generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism Developmental Disorders*. 2000; 30:205–223. [PubMed: 11055457]
- Meadow-Orlans, KP.; Spencer, PE.; Koester, LS. *The world of deaf infants: A longitudinal study*. New York: Oxford University Press; 2004.
- Meltzoff, AN.; Brooks, R. Eyes wide shut: The importance of eyes in infant gaze-following and understanding other minds. In: Flom, R.; Lee, K.; Muir, D., editors. *Gaze-following: Its development and significance*. Mahwah, NJ: Erlbaum; 2007. p. 217-241.
- Moll H, Tomasello M. 12- and 18-month-old infants follow gaze to spaces behind barriers. *Developmental Science*. 2004; 7:F1–F9. [PubMed: 15323111]

- Moore C. Social cognition in infancy. *Monographs of the Society for Research in Child Development*. 1998; 63:167–174. [PubMed: 9835080]
- Mulford, R. Referential development in blind children. In: Mills, AE., editor. *Language acquisition in the blind child: Normal and deficient*. San Diego, CA: College-Hill Press; 1983. p. 89-107.
- Mumme, DL.; Bushnell, EW.; DiCorcia, JA.; Lariviere, LA. Infants' use of gaze cues to interpret others' actions and emotional reactions. In: Flom, R.; Lee, K.; Muir, D., editors. *Gaze-following: Its development and significance*. Mahwah, NJ: Erlbaum; 2007. p. 143-170.
- Mumme DL, Fernald A, Herrera C. Infants' responses to facial and vocal emotional signals in a social referencing paradigm. *Child Development*. 1996; 67:3219–3237. [PubMed: 9071778]
- Mundy P, Block J, Delgado C, Pomares Y, Van Hecke AV, Parlade MV. Individual differences and the development of joint attention in infancy. *Child Development*. 2007; 78:938–954. [PubMed: 17517014]
- Ochs, E.; Schieffelin, BB. Language acquisition and socialization: Three developmental stories and their implications. In: Shweder, RA.; LeVine, RA., editors. *Culture theory: Essays on mind, self, and emotion*. Cambridge, England: Cambridge University Press; 1984. p. 276-320.
- Phelps FG, Doherty-Sneddon G, Warnock H. Helping children think: Gaze aversion and teaching. *British Journal of Developmental Psychology*. 2006; 24:577–588.
- Phillips AT, Wellman HM, Spelke ES. Infants' ability to connect gaze and emotional expression to intentional action. *Cognition*. 2002; 85:53–78. [PubMed: 12086713]
- Posner MI, Snyder CR, Davidson BJ. Attention and the detection of signals. *Journal of Experimental Psychology: General*. 1980; 109:160–174.
- Richman AL, Miller PM, LeVine RA. Cultural and educational variations in maternal responsiveness. *Developmental Psychology*. 1992; 28:614–621.
- Rogoff B, Paradise R, Mejia Arauz R, Correa-Chavez M, Angelillo C. Firsthand learning through intent participation. *Annual Review of Psychology*. 2003; 54:175–203.
- Sabbagh, MA.; Henderson, AME.; Baldwin, DA. What infants' understanding of referential intentions tells us about the neurocognitive bases of early word learning. In: Flom, R.; Lee, K.; Muir, D., editors. *Gaze-following: Its development and significance*. Mahwah, NJ: Erlbaum; 2007. p. 171-191.
- Sodian B, Thoermer C, Metz U. Now I see it but you don't: 14-month-olds can represent another person's visual perspective. *Developmental Science*. 2007; 10:199–204. [PubMed: 17286844]
- Stack, DM. The salience of touch and physical contact during infancy: Unraveling some of the mysteries of the somesthetic sense. In: Bremner, G.; Fogel, A., editors. *Blackwell handbook of infant development*. Malden, MA: Blackwell; 2001. p. 351-378.
- Stack DM, Arnold SL. Changes in mothers' touch and hand gestures influence infant behavior during face-to-face interchanges. *Infant Behavior & Development*. 1998; 21:451–468.
- Stack DM, LePage DE. Infants' sensitivity to manipulations of maternal touch during face-to-face interactions. *Social Development*. 1996; 5:41–55.
- Stack DM, Muir DW. Tactile stimulation as a component of social interchange: New interpretations for the still-face effect. *British Journal of Developmental Psychology*. 1990; 8:131–145.
- Stack DM, Muir DW. Adult tactile stimulation during face-to-face interactions modulates five-month-olds' affect and attention. *Child Development*. 1992; 63:1509–1525. [PubMed: 1446566]
- Striano T, Vaish A. Seven- to 9-month-old infants use facial expressions to interpret others' actions. *British Journal of Developmental Psychology*. 2006; 24:753–760.
- Striano T, Vaish A, Benigno JP. The meaning of infants' looks: Information seeking and comfort seeking? *British Journal of Developmental Psychology*. 2006; 24:615–630.
- Sullivan RM, Toubas P. Clinical usefulness of maternal odor in newborns: Soothing and feeding preparatory responses. *Biology of the Neonate*. 1998; 74:402–408. [PubMed: 9784631]
- Vaish A, Striano T. Is visual reference necessary? Contributions of facial versus vocal cues in 12-month-olds' social referencing behavior. *Developmental Science*. 2004; 7:261–269. [PubMed: 15595366]

- Vaughn, Van; Hecke, A.; Mundy, P. Neural systems and the development of gaze-following and related joint attention skills. In: Flom, R.; Lee, K.; Muir, D., editors. *Gaze-following: Its development and significance*. Mahwah, NJ: Erlbaum; 2007. p. 17-51.
- Waxman RP, Spencer PE. What mothers do to support infant visual attention: Sensitivities to age and hearing status. *Journal of Deaf Studies and Deaf Education*. 1997; 2:104–114. [PubMed: 15579840]
- Woodward AL. Infants' developing understanding of the link between looker and object. *Developmental Science*. 2003; 6:297–311.