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GAZE FOLLOWING: A MECHANISM FOR BUILDING SOCIAL CONNECTIONS BETWEEN INFANTS AND ADULTS

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From the first smile to the first word, infants' social acts are greeted with joy and awe by parents. Regardless of the reason for a smile, parents are hooked—and so are the researchers who study these acts. Parents socially connect with their infants in moments of eye contact and face-to-face interaction; researchers see in these behaviors the foundation of intersubjectivity and reciprocity. However, these joyful, dyadic interactions are destined not to last, because third parties come onto the scene. The mother's eyes stray from her infant to other people and objects, and the infant begins to notice where the mother is looking. Instead of being part of a simple dyad, infants become part of a triangle involving self, mother, and object. This is the birth of what scientists term *triadic exchanges*, in which an external object (whether person or thing) becomes a part of the interaction. The external

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world intrudes on the dyad and expands the primordial relationship between mother and child.

Adults smoothly shift between dyadic and triadic interactions. From a dyadic perspective, when an adult sees his or her social partner look away, this could suggest that the partner is thinking about something, avoiding intimacy, or losing interest (Argyle & Cook, 1976; Kendon, 1990). From a triadic standpoint, adults often make the attribution that the social partner glanced away to look at an important object in the room and perhaps even to communicate interest in it to bring in a new, shared external referent into the interpersonal exchange. The ontogenesis of triadic social interaction is the subject of this chapter.

For adults, shifts of eye gaze are salient social-communicative signals. When a person on the street or in a group suddenly turns to look up in the sky, others in the group tend to follow his or her gaze. The observers are prompted to catch a glimpse of what the other is looking at. Adult observers interpret looking in a certain direction as more than a simple bodily movement; instead, they regard it as a perceptual/psychological act through which they can glean information about the gazer's perceptions, desires, emotions, and intentions.

Gaze following is an entry point for understanding other people's minds. For adults, a person's eye gaze is understood as giving the viewer perceptual access to and/or referring to something in the external world. For example, a person might look at an object with a disgusted facial expression while saying, "I don't like *that*!" or "That's so annoying!" Adults viewing this act can follow her gaze and discover what disgusted or irritated her. Adults follow gaze to help understand what their social partner's emotion is about, and recent work showed that young children do this as well (e.g., Repacholi & Meltzoff, 2007).

Infants begin to notice others' gaze by their first birthdays. This much is uncontroversial. But it is highly controversial how they come to understand gaze as a social-referential signal. Eyes may attract the attention of the newborn: Newborns may be compelled to look at the quickly moving orbs, but do they interpret these movements as indicating mental processes (perception) in the gazer? Do they know that the eyes are pointing to an object that is at the end of the person's line of regard? When does the infant interpret an eye movement as being more than mere movement and as being more a psychological act connecting a viewer to an object?

We hypothesize that infants' own first-person experiences with vision play a vital role in their developing this more sophisticated, psychological notion of gaze. We suggest that infants use their own visual experiences as a lever to help interpret the visual experiences of others like them. We call this the *like-me* developmental theory, and we show in this chapter how it can be applied to a range of issues beyond gaze following itself (Meltzoff, 2007, 2013).

We begin this chapter by making conceptual distinctions between gaze following and other forms of joint engagement that are both broader and narrower than gaze following per se. Next, we discuss the ontogenesis of infant gaze following. Then, we marshal evidence showing that infants' self-experience with their own visual system colors their understanding of others' gaze. The core of this argument is that humans, even preverbal ones, do not come to social relationships as blank slates; rather, infants interpret social interactions through their own past experiences. We conclude with a theoretical discussion that connects gaze following to broader issues concerning the development of interpersonal relations. We theorize that the like-me perceptions that begin in infancy are the developmental origin of the human tendency to divide the social world into ingroups and outgroups. We draw connections between developmental science, social psychology, and neuroscience and argue that the study of infant development can provide foundations for a science of social learning (Meltzoff, Kuhl, Movellan, & Sejnowski, 2009).

Our focus on gaze following complements other approaches in this volume that emphasize (a) the physiological and neural mechanisms supporting social interaction (mirror neurons, oxytocin, and neural reward systems, as discussed in Chapters 1, 3, and 4, this volume) and (b) the individual's psychological and behavioral contributions to harmonious dyadic interactions (synchrony, proximity, and mentalization, as discussed in Chapters 5, 8, and 10). The current chapter brings to the table a developmental viewpoint, showing how seemingly simple behaviors, such as gaze following, illuminate how infants develop an understanding of other people as social agents with perceptions and emotions just "like me." By studying gaze following, we are uncovering a key avenue by which early social connections are formed prior to language.

LOOKING FOR CONNECTIONS: PUTTING GAZE FOLLOWING INTO A LARGER CONTEXT

The literature uses an array of terms and behavioral measures to indicate when a parent and a child share attention toward an external object. These include, among others, *joint engagement*, *gaze following*, and *manual pointing*. In this section, we differentiate and clarify terms to set the stage for the rest of the chapter.

Joint Engagement

Joint engagement occurs when two individuals jointly attend to the same object. For infants, this often happens when they are playing with an

object and their parent is watching them. Infants may interrupt their play to look up and check what the parent is doing or watching. Some researchers have argued that infants are attempting to share visual attention when they initiate eye contact with the adult and shift their own gaze back and forth between the object and the adult, as if to make it a topic of nonverbal "discussion." This type of gaze alternation is often called *coordinated joint engagement* (Bakeman & Adamson, 1984) because it happens at the behavioral rather than the linguistic level. Key to the term's application is that the infant initiates eye contact with an adult rather than looking up in response to the adult's verbal comment. It is the infant who possesses the object and tries to share it with the adult (Carpenter, Nagell, & Tomasello, 1998).

Young infants' alternation of gaze varies as a function of the context. In formal clinical assessments, when infants are already facing an adult tester and an object, 9- to 18-month-old infants consistently make eye contact with the adult and alternate gaze to the object (Mundy et al., 2007). In contrast, in studies of unstructured play with their mothers, infants have only fleeting moments of coordinated joint engagement at 9 months of age, but after they reach 12 months they become more consistent (Carpenter et al., 1998). However, even 18-month-olds spend less than 30% of their unstructured play in coordinated engagement, and these instances occur more often with their parents than with their peers (Bakeman & Adamson, 1984).

The support or scaffolding provided by a social partner may induce joint engagement. When a mother observes her child look back and forth from a toy to her face, the mother may verbally label that toy (i.e., follow-in labeling). This type of parental support prompts infants to alternate gaze before they fully recognize that visual attention connects viewers to objects. In this way, infants may alternate their own gaze between object and parent, without trying to follow their parent's gaze toward objects that lie outside the immediate interaction. (The latter would involve true gaze following, and we will shortly come to this.)

Pointing

Infants can direct others' attention by pointing to objects or events. The prototypical version of this gesture involves extending one's arm and index finger toward an object, although other hand gestures (e.g., using the whole hand as a pointer) are seen in social interactions. Infants usually begin pointing to things or events in their surroundings between 9 and 12 months of age (Butterworth, 2003; Camaioni, Perucchini, Bellagamba, & Colonnesi, 2004).

Bates, Camaioni, and Volterra (1975) distinguished between the types of messages conveyed by pointing, dividing points into proto-imperative meanings ("I want that") and proto-declarative meanings ("Look at that").

Some theorists argue that proto-imperative points do not require infants to appreciate others' visual attention. Rather, it has been argued that infants are simply trying to obtain something by directing the adult's behavior rather than the adult's attention (Colonnesi, Stams, Koster, & Noom, 2010). With respect to proto-declarative points, theorists suggest that infants demonstrate this ability when they point in order to direct and share attention to distal objects (Camaioni et al., 2004; Liszkowski, Carpenter, Henning, Striano, & Tomasello, 2004). Researchers have coded whether or not infants look at others as they point. As pointing emerges near 1 year of age, infants are likely first to point at the event and then to look at the adult (Liszkowski et al., 2004). After 15 months, they are more likely to look at the adult before pointing to the event (Franco & Butterworth, 1996). This change may be relevant to the issue of when the infant is pointing to convey information to the adult.

An interesting way of testing infants' use of pointing as a proto-declarative act of communicating and visual sharing is to assess whether infants change their pointing in relation to what others can see. With a bit of prompting (e.g., with a moving puppet), by 12 to 15 months of age, infants point to a nearby event when the adult did not appear to see it spontaneously (Camaioni et al., 2004). Similarly, Brooks and Meltzoff (2002) reported that 12- to 18-month-old infants were more likely to point to an object when the adult had her eyes open (rather than closed) and thus could observe the infant's point. In situations in which an adult seems to be actively searching for an object after accidentally dropping it on the floor (e.g., a pen falls off a table), 12-month-olds point to the object's location (Tomasello, Carpenter, & Liszkowski, 2007). In this way, infants' use of pointing may indicate some primitive sensitivity to the adult's perspective.

Conceptual Issues in Gaze Following

Gaze following refers to the act of following another person's line of regard. Adult observers seek to catch a glimpse of what a nearby gazer is seeing. But this seemingly simple act involves understanding a number of components. For example, it is not gaze following if a loud plane prompts both the child and the mother to look at the object at the same time, because the synchronized looking would be due to a common third cause (the noise) rather than the infant's perception of the mother's looking behavior. Nor is it gaze following if an infant simply tracks an adult's head movement or bodily orientation and does not process the adult's gaze. In its most sophisticated forms, as shown by adults, the act of gaze following also includes an inference about perception: The observer follows to see what the gazer perceives. In analyzing gaze following and its development, it is useful to distinguish it from other closely aligned phenomena that may seem like gaze following.

Salience of Eyes

Detecting eye gaze is not gaze following per se but is sometimes confused with it. In studies in which faces are presented to infants, even newborns distinguish whether eyespots are directed forward toward them or averted to the side (Farroni, Massaccesi, Pividori, & Johnson, 2004; Johnson, Grossmann, & Farroni, 2008). However, infants may differentiate these displays on the basis of physical properties of the displays, such as whether high-contrast stimuli are centered or lateral, not by understanding gaze per se.

Gaze Detection

In another line of research, shifts of eye gaze have been used to cue the location of nearby targets on a screen (Hood, Willen, & Driver, 1998; Johnson et al., 2008). The classic stimulus in this cuing procedure is a digitized face with eyes that shift to one side before a target appears slightly to the left or the right of the face. The two-dimensional face usually vanishes from the screen before the close-in peripheral targets appear. Adults and infants typically shift their gaze more rapidly to the target that has been cued: If the cue shifts to the right side, they look to a target that appears on the right faster than to one that appears on the left (Frischen, Bayliss, & Tipper, 2007). Under specialized conditions, this cuing effect is seen with newborns (Farroni et al., 2004).

Though interesting, these findings do not provide evidence about following gaze in real-world social interactions. In the real world, when a mother looks at an object, her face does not disappear—yet in the gaze-cuing research that is the procedure used (to allow the infant to disengage from the face and look to the peripheral target). Indeed, if the gaze-cuing procedure is slightly changed so that the face remains on the screen, the face attracts young infants' attention more often than the target and disrupts this specialized effect (Hood et al., 1998). Moreover, in the cuing studies, it is not necessarily the eyes that provide the directional signal to infants: When the whole head and face is artificially displaced laterally (e.g., to the left) and the eyes remain fixed in their original spot on the screen, the apparent motion of the head cues infants to the left (Farroni, Johnson, Brockbank, & Simion, 2000, Experiment 2). This raises the possibility of motion following and not gaze following. Furthermore, in this cuing paradigm the peripheral targets pop into view (after the face vanishes), and this sudden appearance of a target again contrasts with real-world social interactions. In social interchanges, the world remains stable and the adult's gaze spotlights an existing object. In short, infants' sensitivity to directional shifts in the cuing paradigm does not ensure that infants follow the gaze of actual people, and the underlying mechanisms that support these two behaviors may be different.

TESTS OF INFANT GAZE FOLLOWING

In the typical gaze-following paradigm, an adult makes eye contact with the infant and then turns to a distal object that is often outside of peripheral view. This situation gives infants an opportunity to follow the adult's line of regard to the distant object. However, when we are tracking where the person turns, how do we know that infants are following the looker's eye gaze?

Heading Toward Targets

Early reports suggested that infants seem to follow an adult's line of regard by 3 to 6 months of age under certain conditions (see Moore, 2008, for a review). A difficulty in interpreting these findings is that the adult turns his or her eyes and head toward a target. The adult's salient head motion may draw infants' gaze in the correct direction without the infants processing the adult's gaze at all. Empirical evidence and computational models support the claim that salient head movements often drive where infants look (Corkum & Moore, 1995; Triesch, Teuscher, Deák, & Carlson, 2006), which of course is not gaze following at all.

To the extent that this is the case, infants may be pulled in the correct direction by the adult's head turn and then coincidentally notice the object the adult was viewing. This is not gaze following. First, infants are simply following the directional signal of the head motion and not necessarily processing the gaze. Second, although infants are responding to the adult, they are not searching for the target; infants come across an interesting object by coincidence. Third, infants need not make any effort to infer what the adult sees, because the motion is sufficient to attract the infants' attention. Following body or head motion can shift infants' eyes without the infants taking into account the adult's gaze or visual experience.

Following Others' Gaze

We developed a test to determine whether or not infants truly follow gaze (Brooks & Meltzoff, 2002). In this paradigm, an adult turned toward one of two identical targets (situated off to the left and the right side of the infant). The adult's head motion was controlled. Infants were randomly assigned to one of two groups: For one, the adult silently turned toward a target with open eyes, and for the other she turned with closed eyes.

The reason such a manipulation is theoretically crucial is that our eyes are our means of visual perception. We see with our eyes and not our head. An important step toward gaining the adult psychological interpretation of "seeing" is to recognize that the eyes are critical. If infants understand that

the eyes are relevant for connecting the adult and the object, they should differentiate the two conditions and look at the target object only when the adult has open eyes. If, however, infants respond to head movements, they should turn in response to both actions.

Brooks and Meltzoff (2002) tested 12-, 14-, and 18-month-old infants in this eyes open/closed experimental protocol. Infants' reactions were scored with respect to whether infants looked at the correct target (the same target as the adult vs. the opposite target). Infants of all ages looked significantly more often at the target when the adult turned toward it with open rather than closed eyes.

Because we were interested in gaze following as a component of social connectedness to others, we also examined a broader network of social acts (pointing, vocalizing) during the gaze-following tests. First, we measured infants' average duration of correct looking to examine how long the infants stared at a correct target (i.e., the adult's target) once they gaze followed. We discovered that infants inspected the target longer when the adult turned with open rather than closed eyes. We also found that infants vocalized toward the correct target more in the open-eyes than in the closed-eyes group. Finally, significantly more infants pointed to the correct target in the open-eyes group than in the closed-eyes group. The results indicate that infants notice others' eye status and selectively look, vocalize, and point at the target when the adult can see it.

These findings are important because they help us interpret gaze following. The leanest interpretation has been that an adult's movement attracts infants' attention to a hemifield of space where the infants (by chance) see an interesting object. This could not explain the results from our study, however, because head motion was controlled. Moreover, infants marshal other target-directed acts in a selective manner, such as pointing at the target and vocalizing toward it when the adult can see the target. The infants are not imitating the adult because they are generating communicative acts that the adult herself did not produce. Infants cannot be pointing solely because they are interested in the colorful targets, because the objects are equally available in both conditions. Infants point when the social partner can see the objects but refrain when the partner cannot see them.

Finally, the duration measure also helps make sense of infants' behavior within a social context. If the conservative proposal that the adult's head movement simply brings the infant's attention to the object were correct, this would not explain why infants inspect the object longer when the adult's eyes are open rather than closed. The object itself is the same whether the adult turns toward it with open or closed eyes. However, the infants treat the target object as if it has a special value once the social partner has looked at it. It is as though the adult has shone a psychological spotlight on it, motivating

intense infant inspection of it. Infants' selective looking, pointing, and vocalizing when the adult's eyes are open suggests that infants are treating others as social agents who see and whose visual perception can be directed.

Developmental Roots of Infant Gaze Following

The work reviewed so far shows that 12-month-old infants follow others' gaze. A pressing question concerns younger infants. Because there are changes in social interactions near 9 months of age (Bråten, 2007), we selected children of that age for study. Brooks and Meltzoff (2005) recruited infants for a visit within 1 week of becoming 9, 10, or 11 months of age. Infants were randomly assigned to either the open- or the closed-eyes condition.

The results showed that 9-month-olds did not discriminate between the open- and closed-eyes conditions. They turned equally often in the two cases. It is important to note that 9-month-olds did not fail to follow the adult. In fact, they turned frequently even when the adult turned with closed eyes, as if they did not process their social partner's ability to see. However, there was a developmental transition. By 10 months, infants tended not to follow the turns of the closed-eyed adult. For the 10- and 11-month-olds, the gaze-following scores in the open-eyes group were significantly greater than those in the closed-eyes group. By 10 months, but not by 9 months, infants were genuinely following the gaze of their social partners.

These results are theoretically important because of claims that gaze following starts as early as 3 or 4 months of age. At first, these reports seem to contradict our assertion that the development of gaze following occurs at 10 to 11 months of age. But there is no contradiction. We believe that infants turn to follow the direction of head movements and postural changes at 9 months and younger. These young infants turn even if the adult cannot possibly be looking at the target, and thus they are not truly gaze following. We think that infants 9 months old and younger construe others as "body orienters" and are sensitive to the postural changes of adults in relation to objects. The first evidence for exhibiting true gaze following and treating the social partner as a psychological, visually perceptive agent is at 10 to 11 months.

In sum, by 10 to 12 months, following head motion alone does not explain why infants look at an adult's visual target. The 10- to 11-month-old infants selectively follow the turns of an adult with open eyes and rarely follow the turns of an adult with closed eyes, even though the head motion is the same for the two types of head turns (Brooks & Meltzoff, 2005). Older infants begin to understand others as visually connected to the external world and turn to follow another person's gaze. This is an important step in understanding another person as an intentional perceiver (a looker, a gazer). Recent work with "social robots" has extended this work to investigate in detail what constitutes an entity whose gaze the child will follow (Meltzoff, Brooks,

Shon, & Rao, 2010). Infants were more likely to follow the "gaze" of a robot after they had seen a person and the robot engage in a social interchange (e.g., imitating each other) than when this social connection was not built up. This finding underscores that gaze following is part of a larger network of ideas that the infant is developing about social cognition.

Links Between Gaze Following and Language

Gaze following gives infants a nonverbal means to connect to and interact with their social partners. However, verbal exchanges soon expand infants' social repertoire. From a theoretical perspective, following gaze could provide important social-cognitive support for acquiring language (e.g., Baldwin, 2000; Carpenter et al., 1998; Kuhl, 2004; Mundy, Sullivan, & Mastergeorge, 2009). For example, when a parent says, "There's the ball," the parent is likely staring at a ball. An infant who gaze follows can learn what visual object goes with the verbal label.

To empirically test this idea, Brooks and Meltzoff (2008) conducted a longitudinal study of the children who had come into the lab at 10 to 11 months of age (the youngest ages with clear evidence of gaze following). Parents reported their infants' productive vocabulary for the ages of 10–11, 14, 18, and 24 months. We tested whether the gaze-following behavior of infants (before they started talking) predicted the rate of their subsequent vocabulary growth. The hypothesis was that early social understanding would be positively correlated with subsequent language development, showing the interweaving of social development and language development.

The results showed that infants with better gaze-following ability had faster vocabulary growth. In particular, the duration measure of gaze following was a significant predictor of the number of words infants produced through 24 months of age. Infants who had extended looks at the target were the infants who had larger vocabularies, whereas infants with short (or no) glances at the adult's target had smaller vocabularies by 24 months of age. Infants' gaze-following ability was still a significant predictor of language outcome, even after controlling for background parental factors such as maternal education.

The empirical findings confirm the theoretical position that gaze following supports and indeed accelerates word learning. Longer looks seem to indicate that the target acquired a special valence when another person looked at it, arousing the infants' curiosity and desire to visually inspect it. Infants who tend to react in this way may have great opportunities to learn the names of objects. They linger on an object long enough to hear a verbal label applied to it by the adult. This work fits well with other findings that infants more readily learn language during social exchanges with human social partners than from TV, which does not afford social interactivity in the same way that a flesh-and-blood person does (see Meltzoff et al., 2009, for a review).

MECHANISM OF CHANGE: INFANTS' OWN EXPERIENCES WITH SEEING

The difference between open eyes and closed eyes is not the only distinction that infants need to make if they are to understand social exchanges in the real world. People can look through a window but cannot see through a wall. Do infants realize that barriers, such as walls and other inanimate objects, block one's line of sight?

We have used a procedure similar to the open/closed eyes paradigm to explore what infants understand about inanimate occluders (Brooks & Meltzoff, 2002). In these studies, for one group of infants, an adult turned with a cloth (blindfold) blocking her view. For infants in the other group, she had a clear view because the cloth was worn on her forehead as a headband. This at first seemed like a minor variation, but the results were surprisingly different from those in the study with open or closed eyes.

The 12-month-olds mistakenly followed the adult's turn when she wore the blindfold. They turned equally as much when the adult was wearing the headband as when she was wearing the blindfold (Brooks & Meltzoff, 2002, Experiment 2). In contrast, the infants at 14 and 18 months distinguished between the two conditions. The older infants rarely followed the turns of the blindfolded adult, whereas they did follow the turns when the cloth was on her forehead as a headband. It seems that 1-year-olds know that eye closure blocks an adult's vision, but they do not know that inanimate occluders do.

Why do infants understand eye closure at an earlier age than they do blindfolds? A theory based on salience of head motion cannot explain why there would be this difference because both actions used the same head motion. Further, infants do not seem to use a general rule, such as "I can (or cannot) see your eyes," to solve this problem: The adult's eyes were not visible in either the blindfold or the eyes-closed condition, yet those conditions prompted different responses from the 12-month-old infants.

We propose that the difference between eye closure and a blindfold is infants' own experience and sense of agency. Infants amass visual experience by opening and closing their own eyes; when they close their eyes, they can no longer see. We believe that infants use their own phenomenological experience gained by closing their eyes to give meaning to the corresponding acts of others.

If this hypothesis is correct, giving infants experience that blindfolds block their view should make a difference. Meltzoff and Brooks (2008) conducted the relevant experiment with 12-month-olds. Infants sat at a table and played with an object. Next, the adult gently raised a blindfold to block infants' vision. The adult then lowered the cloth and play resumed. This process was repeated in a game-like fashion with other objects for about 7 minutes. This provided infants with first-person, self-experience about how

the blindfold blocked their own view. Our question was whether this self-experience changed the infants' understanding of their social partners. To test this, we then had, for the first time, the adult wear the blindfold, and we administered the standard gaze-following test.

The self-experience changed infants' interpretation of the adult's behavior. Infants no longer followed the blindfolded adult's "gaze" to the object, whereas the 12-month-olds without blindfold experience still followed (Meltzoff & Brooks, 2008). We thus discovered that infants could generalize from their own experience to that of their social partner. Because they could not see when a blindfold was in front of their eyes, they inferred that the adult could not see in a similar situation.

In the typical course of development, infants change their understanding of visual perception. By 14 to 18 months of age, infants do not act as though adults can see through opaque barriers, and they refrain from gaze following if an opaque barrier blocks the adult's view (e.g., Butler, Caron, & Brooks, 2000; Dunphy-Lelii & Wellman, 2004).

To press the self-experience idea one step further, Meltzoff and Brooks (2008, Experiment 2) provided 18-month-olds with novel experience that countered their expectation about opaque occluders. We designed a trick blindfold that looked opaque from the outside but that was made of special material that could be seen through when held close to the eyes. Infants were randomly assigned to one of three groups: experience with this trick blindfold, experience with the opaque blindfold, and a baseline control condition (familiarity with the blindfold lying flat on the table). After training, infants saw the adult wear the blindfold in the standard test. We discovered that infants who had first-person experience with the trick see-through blindfold followed the adult's head turns significantly more often than did infants in the other two groups.

The effects of training demonstrate that infants' own visual experiences have a powerful effect on their interactions with others. The information infants learned through self-experience was immediately applied to social others. As infants gain firsthand experience, they transform their understanding of others who are "like me." This "like-me" mechanism allows infants to use their own experiences to give meaning to the acts of other social agents (Meltzoff, 2007).

CONCLUSION

Gaze following is fundamental to everyday social-cognitive understanding. For adults, it is not simply that the other person turns his or her head to the side; rather, the other person's eye gaze is interpreted as an act of perception,

a psychological link between viewer and object. For this reason, developmental scientists have considered gaze following a front-end ability that helps promote the development of understanding other minds. Individual differences in following gaze are important partly because they predict language development (Brooks & Meltzoff, 2008; Mundy et al., 2007). Gaze-following deficits are of particular concern for children with autism spectrum disorders. It has been argued that these deficits in decoding the meaning of people's looking at objects may contribute to downstream deficits in language and social understanding (Baron-Cohen, 1995; Mundy et al., 2009; Toth, Munson, Meltzoff, & Dawson, 2006) including deficits in more sophisticated aspects of perspective taking (e.g., Moll & Meltzoff, 2011), which can be thought of as developmental sequelae of infant gaze following.

Gaze following is itself a developmental accomplishment, and it helps illuminate changes in infants' social cognition. Infants begin to follow the gaze of others before their first birthdays. By 10 to 12 months, infants distinguish between open and closed eyes, as shown by their selectively following turns of an adult with open eyes. They begin to treat their eye-orienting partner as making a perceptual act and to treat gaze as a psychological connection between the gazer and a distal object. The ontogenesis of gaze following gives infants an emerging means to interpret the behavior of others and thus facilitate the formation of interpersonal connections.

We come now to a crucial argument about infants using their own first-person experience to understand others. When infants explore their surroundings, they have opportunities to play with their visual experiences, such as closing their eyes to shut out unwanted stimulation. These experiences help infants develop resources for interpreting the acts of others who are "like me" (Meltzoff, 2007, 2013). As infants open and close their eyes—seeing versus shutting out the world—they learn about the consequences of eye closure and can rapidly generalize this experience to other social agents "like them." We provided an experimental test of this idea of interpersonal projection. We systematically manipulated infants' experience that a blindfold could block their own view of the external world; next, we tested whether this changed their interpretation of how the blindfold affected the visual experience of a social partner (Meltzoff & Brooks, 2008). These studies provided empirical evidence to support the claim that infants' own experiences with occlusion and vision color how they interpret the visual experiences of others. This pattern of findings fits well with the "like-me" theory of infant social-cognitive development (Meltzoff, 2007), which holds that infants use their own bodily experiences to give meaning to others' acts and reciprocally rely on their observations of others' acts to change themselves.

Meltzoff (2013) theorized that the infantile proclivity to see others as "like me" is the foundation for the ontogenesis of ingroup affinities. Social

psychologists have long been interested in the psychological processes by which we develop the "us" versus "them" distinction (e.g., Heider, 1958; Tajfel, 1981), but the origins have been little explored. The "like-me" attributions made by infants in gaze-following experiments may reveal the developmental origins of people's tendency to identify with others and their sense of belonging to certain social groups (e.g., Cheryan, Meltzoff, & Kim, 2011; Cvencek, Greenwald, & Meltzoff, 2011). We have begun to explore the neuroscience correlates of this powerful "like-me" judgment in young children (Marshall & Meltzoff, 2011; Saby, Marshall, & Meltzoff, 2012) in an effort to connect developmental science, social psychology, and neuroscience (e.g., Jackson, Meltzoff, & Decety, 2005; Lamm, Meltzoff, & Decety, 2010), a grand challenge also explored by many others, such as Decety and Howard (see Chapter 6, this volume) and Ellemers, van Nunspeet, and Scheepers (see Chapter 20).

In summary, the study of gaze following contributes to an interdisciplinary examination of key building blocks for social cognition and begins to illuminate mechanisms of early developmental change. The eyes and the actions of adults provide a foundation on which infants can build social connections between self and other, and they reciprocally provide adult scientists a way of understanding the minds and hearts of infants, who are too young to speak for themselves.

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