Meltzoff, A.N. (2013). Origins of social cognition: Bidirectional self-other mapping and the "Like-Me" hypothesis. In M. Banaji & S. Gelman (Eds.), *Navigating the social world: What infants, children, and other species can teach us* (pp. 139-144). New York, NY: Oxford University Press.

# 3.3

# Origins of Social Cognition

## *Bidirectional Self-Other Mapping and the "Like-Me" Hypothesis*

ANDREW N. MELTZOFF

Human social cognition begins in the newborn period. When the human newborn opens its eyes and sees a human act for the first time, I have proposed that this engenders a feeling of interpersonal connectedness. To explain the idea, I offered the "Like-Me" developmental hypothesis. The key suggestion is that perceiving others as like me is a social primitive. The new empirical research shows that the core sense of similarity to others is not the culmination of social development, but the precondition for it. Without this initial felt connection to others, human social cognition would not take the distinctively human form that it does.

In the past, philosophers, social theorists, and psychologists have considered related ideas, but the foregoing departs from historical discussions in four ways. First, the relevant philosophers (e.g., Husserl, Merleau-Ponty, Ryle) did not imagine that this process begins at birth. These philosophers postulated that self-other mapping and first steps toward cracking the problem of Other Minds were late emerging and mediated by language and/or deliberate introspective reasoning.

Second, many sociologists and social psychologists working with adults gave priority to social learning from the outside in: An unformed self is given coherence by how others react to it (Cooley, Mead)—the "looking-glass self." Instead, as I will show, infants also use self-experience to give meaning to the observed behavior of others in ways these theorists missed.

Third, Piaget's work with infants led him to theorize that they start out as "solipsists" with no links between self and other. Piaget was unable to provide a satisfactory mechanism of change from initial solipsism to the rich social cognition of 5-year-olds, because he underestimated the initial state. Freud's and Baldwin's neonatal "adulism," merging, or lack of differentiation between self and other suffers from the same problem, and were precursors to Piaget's more sophisticated writing on the initial state.

Fourth, although contemporary work on social primitives has shown that infants have visual preferences for faces (Johnson and Morton), eyespots (Baron-Cohen), and self-mobile entities (Leslie), my proposal goes beyond cues that induce infant visual attention. Infants' supramodal representation of human action maps external events to the self. Crucially, this goes beyond heightened attention, preference, and visual expectations.

In this essay I will discuss empirical studies concerning two social learning mechanisms that build on the "like-me" primitive—imitation and gaze following. The studies illuminate three aspects of social cognition: (a) origins, (b) mechanisms of change, and (c) bidirectional learning between self and other. The studies support the view that "like me" is a social primitive that gives rise to a life-long ability to connect to other humans, which is vital to our survival as a species.

Humans have a long period of infantile immaturity compared to other animals. This immaturity has coevolved with powerful social learning mechanisms. Two of these social learning mechanisms—imitation and gaze following—are functional in human infancy, rare in the animal kingdom, and impoverished in autism. If one seeks to understand the birth, growth, and mechanisms of change in human social cognition, imitation and gaze following are promising domains to investigate.

Imitation supports rapid learning of behavioral skills, social customs, and causal relations by observation. Rather than relying purely on maturation (which is not responsive to cultural contingencies), independent invention (which is slow) or trial and error (which can be dangerous), humans excel in imitative learning from others in

the environment. A key to human imitation is that it is not slavish or mindless duplication. Children and adults selectively regulate who, what, and when to imitate. Imitative learning is a chief avenue for social learning prior to language, but it also plays a role when adults are in novel social settings. Visiting a foreign country in which social greetings and eating implements differ from ours reminds us of the value of imitating experts rather than reliance on trial and error or invention.

Following the gaze of other people directs our attention to particular regions of space. Our attention is directed to locations, objects, and events that are particularly rich in information. These "information hot spots" do not stand out based on physical cues alone. They are not necessarily bigger, brighter, or more visually conspicuous. They gain psychological salience merely because a social other has looked at them. Perceptual alignment with others undergirds common ground for communication and supports pedagogy and collaborative learning.

## IMITATION AS SOCIAL COGNITION

### Bodily Imitation

In facial imitation, infants are duplicating a gesture they see with a gesture of their own that they cannot see themselves make. Developmentalists have known for more than 50 years that 1-year-olds imitate facial gestures, but it was a surprise to discover that newborns as young as 42 minutes old imitate such acts (Meltzoff & Moore, 1983).

Newborn facial imitation provides information about the initial state of social cognition. Newborns can see another person move but have never seen their own face. This apparent gulf between self and other is reminiscent of the Other Minds problem in philosophy (albeit at the level of actions and not intentional states). We know ourselves from the inside and others from the outside: How do we understand what it is like to be another person, to feel what the other person feels?

I have argued that imitation is based on active intermodal mapping, positing a primitive and foundational body scheme that allows infants to unify the seen acts of others and their own felt acts in a shared framework. Meltzoff and Moore (1997) postulated that human infants accomplish this via a "supramodal" representation of human acts. Links between perception and production do not have to be forged through associative learning but are available to the newborn. Imitation is a congenital aspect of human social cognition, with much known at the behavioral-psychological level, and rapid progress being made illucidating infant neural mirroring mechanisms (e.g., Marshall & Meltzoff, 2011; Saby, Marshall, & Meltzoff, 2012).

Infants' self-experience may play a role in imitation. Even at birth infants have had experience with self-generated movements, which we call *body babbling* (Meltzoff & Moore, 1997). Films of prenatal behavior, for example, reveal that fetuses make repeated lip, tongue, and hand movements in utero. Body babbling provides infants with experience in how their own body moves. Body babbling is a mechanism for infants' learning about controlling their body, analogous to how vocal babbling provides experience in vocal maneuvers (Kuhl & Meltzoff, 1982). Tongues move differently from hinged joints such as fingers and elbows. Based on self-experience with the felt movements of one's own body, the kinetic signatures of a tongue protrusion/withdrawal (or mouth opening/closing, or finger flexing) could be recognized as cross-modally equivalent to those produced by others.

### Personal Identity

Theories of developing social cognition must be concerned with personal identity. How does an infant distinguish one person from another and reidentify a person as the "same one" again despite changes in surface appearances? Infants' social worlds would be very different from ours if an interpersonal relationship were not maintained when the surface features of the other were altered. This is related to the topic of object individuation and numerical identity (Moore & Meltzoff, 2009; Spelke, Breinlinger, Macomber, & Jacobson, 1992; Xu & Carey, 1996), but considers the identity of people who disappear and reappear and change appearance.

We discovered that infant imitation contributes to infants' understanding of personal identity. Infants use both a person's spatial history (spatiotemporal parameters) and the prior experience of interacting with that person (functional parameters) to determine a person's identity. When infants are ambiguous about whether this is the same person they saw previously, infants show increased imitation of the person's past behavior, as if verifying "Are you the one who does x?" Body actions, mannerisms, and distinctive interactive games and routines played by particular people are akin to nonverbal shared memories that can be used as identity markers of people.

The value of using human acts as criteria for identity is that they allow infants to test as well

as to observe. Instead of being limited to generalized reactions, such as smiling, cooing, and greeting of "humans in general," infants have a tool for intervening to actively probe whether they are re-encountering the same individual after a perceptual break or change in appearance. Social beliefs and attitudes are often about specific people, not categories. For infants who cannot yet use language to query a person, keeping track of individuals requires combining observation (spatiotemporal criteria) and action experience with that person (functional criteria) to make judgments about a person's identity.

## The Imitation Game: Being Imitated Begets Social Bonding

One of the favorite activities of parents and children are reciprocal imitation games, and I argue that these games support social bonding and affiliation. Why are these mutual imitation games so alluring for infants? Temporal contingencies are part of the story, but it is often overlooked that people are special to infants because they can systematically match the form of their behavior in a generative fashion. This structural congruence is psychologically salient to infants (and adults).

In one study we gave infants a choice between two adults who were sitting side by side, one imitating what the infant did and the other acting contingently on the infant's actions but producing a mismatching action. The infants selectively looked longer and smiled more at the matching adult (Meltzoff, 1990). Infants' attention and positive emotions were directed at the one who acted "like me."

There are two key social-developmental sequelae. First, mutual imitation games deepen a sense of relationship. Mutual imitation indicates "communing" or "being with" someone else, even prior to the time that linguistic exchanges are possible. Adults develop positive feelings toward another person who is reflecting their behavior back to them, despite not being aware of the cause of these feelings in psychotherapeutic and everyday settings (Ogden, 1982; van Baaren, Holland, Steenaert, & van Knippenberg, 2003). We see the seeds of this in the reciprocal imitation games in preverbal infants.

Second, caretakers' mirroring serves the functions as a physical mirror. Infants can use imitative interactions to learn what the self looks like. This provides a lever for developmental change, because early facial imitation is mediated by supramodal equivalence, and infants can accomplish it without modality-specific information being preserved. Neonates can successfully imitate without yet knowing what their acts *look like* in a purely visual sense from the outside. Classical developmental and psychoanalytic theory (e.g., Lacan) implicated physical mirrors in the ontogenesis of a visual self, but this cannot be the only source. Mirrors are not culturally universal or historically ancient. Mutual imitation provides another mechanism. Through such social mirroring, infants gain a better sense of what their own felt acts look like.

Social neuroscience studies of mutual imitation in adults show that the right inferior parietal lobe is activated when people experience themselves being imitated (Decety, Chaminade, Grèzes, & Meltzoff, 2002). A speculation is that the right inferior parietal lobule is involved in differentiating self and other when they are both performing the same actions (a neural "who done it"). Related social neuroscience work is now emerging in infants (Saby, Marshall, & Meltzoff, 2012).

## GAZE FOLLOWING

For adults, human attention implicates both external objects and the internal states of the viewer. When we see someone turn to look at an object, this is interpreted as more than a simple physical motion in space. It is recognized as an attempt to acquire information from afar despite the gap between the person and thing. Visual perception is a kind of psychological contact at a distance.

When do infants begin to ascribe visual perception to others' acts of looking, and how do they come to make this attribution? I believe that infants in part develop an understanding of the visual perception of others through their self-generated acts of turning in order to see and opening/shutting their eyes to cut off and reinstate visual experience. Self-experience changes their interpretation of the visual behaviors of others.

## Self-Experience: Learning From the Inside Out

This idea that infants' own visual experiences contribute to their understanding of others' vision emerged from a puzzling finding. In a gaze-following study, an adult sat across from the infant and turned to face objects on a random schedule. Twelve-month-olds followed the adult significantly more when her eyes were open rather than closed (Brooks & Meltzoff, 2002). These infants seemed to understand that eye closure occludes vision, but this understanding was constrained—the same 12-month-olds turned when

the adult wore a blindfold, which also occludes vision. Why?

Infants control their own vision by closing their eyes. We hypothesized that extensive self-experience turning off/on visual access through eye closing/opening provides a basis for understanding similar behaviors in others. This predicts that if infants are given experience that blindfolds block their view they should make new attributions to others, and they did. Meltzoff and Brooks (2008) gave 12-month-olds experience with blindfolds occluding their vision. After this experience, infants treated adults wearing blindfolds differently. Infants who received first-person experience with the blindfold treated the adult as though her view was blocked, suggesting that their first-person experiences changed their attributions to others. Self-experience provided a "like-me" framework for interpreting the other's experience.

We also discovered that self-experience can teach infants novel information that violates the notions of everyday visual opacity. It is well established that by 18 months infants know that opaque barriers such as walls, barriers, and blindfolds occlude the adult's line of regard. We provided 18-month-olds with biologically deviant self-experience. We designed a trick blindfold that looked opaque from the outside but was made of special material that could be seen through when held close to the eyes. Infants given an intense bout of this self-experience generalized from self to others and treated the blindfolded adult as if she too could see through it: They followed her gaze to distal objects (Meltzoff & Brooks, 2008). As infants gain first-person experience, they flexibly transform their understanding of others. Self-experience can induce a change in understanding the other.

### Self-Experience Is Not the Royal Road to Social Cognition

Is self-experience the sole path for coming to understand the inner workings of other people? My research and theory, and those of others, strongly suggests not. Infants also come to understand others as bearers of psychological states by observing structured patterns of their behavior.

To test this, we modified the blindfold paradigm used with 18-month-olds. Infants were not given self-experience. They watched a blindfolded adult reach out and grab objects on the table in front of them. We thought that this "visually guided behavior" would be sufficient to support the inference that the adult is seeing. Infants in one control group saw the same adult wearing the same blindfold and making fumbling reaches as if she could not see. Infants in another control saw the adult wearing the black cloth as a headband and successfully grabbing the objects.

Infants who saw the blindfolded adult make visually guided reaches were significantly more likely to follow the adult's line of regard than the control infants. This suggests that infants can draw inferences about whether the person can or cannot see based on observing a structured pattern of goal-directed behavior. The infants inferred sight because the blindfolded adult could systematically reach out and pick up distal objects. Thus, infants followed her gaze to the external object. This is significant, because it contradicts the infants' own self-experience with opaque cloths. (For related work, see Williamson & Meltzoff, 2011.)

## "SOCIAL ROBOTS"

Infants do not "gaze follow" in response to every movement in the visual field. If the wind blows the door opens, they are unlikely to follow where the doorknob is pointing. We investigated who or what infants would gaze follow. We showed 18-month-old infants a robot and experimentally varied how it interacted with others.

The effective manipulation was witnessing the robot having a social interaction: If the robot engaged in imitative exchanges with a person, the infants seemed to attribute sentience to the robot and to follow its gaze. When a robot simply moved its head (complete with eyespots) to the side, infants did not gaze follow. When the robot exhibited identical motions as the adult, but not as part of a reciprocal social interaction, gaze following did not occur. (Meltzoff, Brooks, Shon, & Rao, 2010).

It is not solely the visual features or movements of an entity, but the *interactions* it engages in, that are cues of social cognition. Reciprocal imitation is interpreted as a marker of psychological agency. An entity that systematically imitates is one that perceives. Infants draw social-cognitive inferences from watching structured patterns of behavior—in this case social interaction—and do not require self-experience with the robot (in closely related studies such as Johnson, Slaughter, & Carey, 1998, there was contingent interaction between the infant and the nonhuman entity).

## CONCLUSIONS

The primitive on which social cognition rests is the perceived "like me" equivalence between self and other. This provides infants, even newborns, with a feeling of kinship with fellow humans, and

it supports bidirectional learning from and about people.

Going from the direction of inside out, infants' own self-experiences change their understanding of others. I have discussed instances of this projection from self to others. Infants who experience that a blindfold occludes their own vision make new attributions to others who wear it. Another example comes from infants' heightened attention and positive emotion at being imitated. Infants prefer those who act "like me" as manifest through prosocial acts such as smiling at the imitating adult. Later in development, children and adults exhibit positive attitudes toward those who share features of the self that go beyond action. "Like-me" preferences (initially based on shared actions) are building blocks for the in-group positivity that later develops based on gender and other characteristics (e.g., Cvencek, Greenwald, & Meltzoff, 2011; Dunham, Baron, & Carey, 2011). Adults prefer and feel empathy for those who are "like me" along abstract dimensions such as religion, nationality, and social class, but a sense of "us" versus "them" has its first instantiation in the felt kinship for those who *act* "like me."

Infants also acquire new information about themselves and the world simply by observing others—demonstrating outside-in learning. I discussed that observing a structured pattern of behavior supports infants' inferences about the psychology of others. At a more basic level, studies of infant imitation show that they do not require extensive prior experience with an action to imitate it. Infants readily imitate novel acts (Meltzoff, Kuhl, Movellan, & Sejnowski, 2009). They also learn novel causal relations based on observing the outcomes of others' goal-directed interventions (Meltzoff, Waismeyer, & Gopnik, 2012). The human capacity for the imitation of novel acts and observational causal learning are noteworthy—they free us from learning about people and things only via self-experience.

Developing social cognition, even in infancy, requires a bidirectional mapping between self and other, and children with autism have specific deficits in this bidirectional system. An initial "like-me" equivalence between self and other allows social cognition to get off the ground. Later bidirectional learning—from self to other and other to self—allows it to soar.

## ACKNOWLEDGMENTS

Supported by the National Science Foundation (SMA-0835854), the National Institutes of Health (HD-22514), and the ONR (N00014-0910097). I thank P. Kuhl, R. Williamson, R. Brooks, D. Liu, and P. Marshall for helpful comments on an earlier draft, and K. Moore and A. Gopnik for useful discussions.

## REFERENCES

Brooks, R., & Meltzoff, A. N. (2002). The importance of eyes: How infants interpret adult looking behavior. *Developmental Psychology*, *38*, 958–966.

Cvencek, D., Greenwald, A. G., & Meltzoff, A. N. (2011). Measuring implicit attitudes of 4-year-olds: The Preschool Implicit Association Test. *Journal of Experimental Child Psychology*, *109*, 187–200.

Decety, J., Chaminade, T., Grèzes, J., & Meltzoff, A. N. (2002). A PET exploration of the neural mechanisms involved in reciprocal imitation. *NeuroImage*, *15*, 265–272.

Dunham, Y., Baron, A. S., & Carey, S. (2011). Consequences of 'minimal' group affiliations in children. *Child Development*, *82*, 793–811.

Johnson, S. C., Slaughter, V., & Carey, S. (1998). Whose gaze will infants follow? The elicitation of gaze-following in 12-month-olds. *Developmental Science*, *1*, 233–238.

Kuhl, P. K., & Meltzoff, A. N. (1982). The bimodal perception of speech in infancy. *Science*, *218*, 1138–1141.

Marshall, P. J., & Meltzoff, A. N. (2011). Neural mirroring systems: Exploring the EEG mu rhythm in human infancy. *Developmental Cognitive Neuroscience*, *1*, 110–123.

Meltzoff, A. N. (1990). Foundations for developing a concept of self: The role of imitation in relating self to other and the value of social mirroring, social modeling, and selfpractice in infancy. In D. Cicchetti & M. Beeghly (Eds.), *The self in transition: Infancy to childhood* (pp. 139–164). Chicago, IL: University of Chicago Press.

Meltzoff, A. N., & Brooks, R. (2008). Self-experience as a mechanism for learning about others: A training study in social cognition. *Developmental Psychology*, *44*, 1257–1265.

Meltzoff, A. N., Brooks, R., Shon, A. P, & Rao, R. P. N. (2010). "Social" robots are psychological agents for infants: A test of gaze following. *Neural Networks*, *23*, 966–972.

Meltzoff, A. N., Kuhl, P. K., Movellan, J., & Sejnowski, T. J. (2009). Foundations for a new science of learning. *Science*, *325*, 284–288.

Meltzoff, A. N., & Moore, M. K. (1983). Newborn infants imitate adult facial gestures. *Child Development*, *54*, 702–709.

Meltzoff, A. N., & Moore, M. K. (1997). Explaining facial imitation: A theoretical model. *Early Development and Parenting*, *6*, 179–192.

Meltzoff, A. N., Waismeyer, A., & Gopnik, A. (2012). Learning about causes from people: Observational causal learning in 24-month-old infants. *Developmental Psychology, 48,* 1215–1228.

Moore, M. K., & Meltzoff, A. N. (2009). Numerical identity and the development of object permanence. In S. Johnson (Ed.), *Neoconstructivism: The new science of cognitive development* (pp. 61–83). New York: Oxford University Press.

Ogden, T. H. (1982). *Projective identification and psychotherapeutic technique*. New York: Aronson.

Saby, J. N., Marshall, P. J., & Meltzoff, A. N. (2012). Neural correlates of being imitated: An EEG study in preverbal infants. *Social Neuroscience, 7*, 650–661.

Spelke, E. S., Breinlinger, K., Macomber, J., & Jacobson, K. (1992). Origins of knowledge. *Psychological Review*, *99*, 605–632.

van Baaren, R. B., Holland, R. W., Steenaert, B., & van Knippenberg, A. (2003). Mimicry for money: Behavioral consequences of imitation. *Journal of Experimental Social Psychology*, *39*, 393–398.

Williamson, R. A., & Meltzoff, A. N. (2011). Own and others' prior experiences influence children's imitation of causal acts. *Cognitive Development*, *26*, 260–268.

Xu, F., & Carey, S. (1996). Infants' metaphysics: The case of numerical identity. *Cognitive Psychology*, *30*, 111–153.