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THE EMERGENCE OF EMPATHY DURING INFANCY

Ted HUTMAN[1], Mirella DAPRETTO[2]*

[1] Department of Psychiatry & Biobehavioral Science,
David Geffen School of Medicine, University of California, Los Angeles, USA
[2] Ahmanson-Lovelace Brain Mapping Center, Los Angeles, USA

ABSTRACT

Empathy refers to the interpersonal sharing of emotional states brought about by knowledge or observation by one person of the other person's experience or emotional state. This review presents several models of empathy and summarizes empirical research regarding the emergence and development of componential skills. The earliest emerging skills discussed are imitation, emotion matching, and emotional contagion. We provide support for the claim that these capacities, evident from the first hours of life, strengthen the relational bonds between infants and caregivers. In the context of early attachment relationships, infants learn emotion regulation and responsiveness to affective signals. At approximately ten months, infants begin to regulate their behavior on the basis of affective messages from adults. The emergence of empathy has been studied by observing infants' responses to other people's distress. Responses to distress undergo changes during the second year such that self-distress responses decrease and prosocial responses increase. These changes co-occur with the achievement of several important milestones in cognitive development such as self-recognition, agency, and awareness of other perspectives. The behavioral markers of developing empathic abilities during this period are presented in conjunction with findings regarding the neurobiology of empathy in childhood. Suggestions are made for approaches to fill gaps in our understanding of the emergence of empathy during infancy.

KEYWORDS: *development, empathy, emotion, affective sharing, emotional responsiveness.*

[*] Corresponding author:
E-mail: thutman@mednet.ucla.edu.

Determining the age at which infants display empathy depends in large part upon the way the construct is defined. Most models of empathy involve "an affective response that is more appropriate to another's situation that one's own" (Hoffman, 2000, p. 4). Hoffman's model (1982, 1983) additionally emphasizes a motivational component of empathy and its role as a catalyst of altruistic behavior. Preston and de Waal (2002) propose a "process model of empathy", based upon mechanisms that support a class of responses that includes emotional contagion, sympathy, cognitive empathy, and prosocial or helping behavior. According to their model, "attended perception of the object's state automatically activates the subject's representations of the state, situation, and object, and that activation of these representations automatically primes or generates the associated autonomic and somatic responses, unless inhibited" (p. 4). In contrast, other models of empathy propose a more developmentally advanced construct that requires self-other differentiation and subjective understanding of the other person's state. For instance, Eisenberg and colleagues (1998) propose that empathy is "an affective reaction that results from the apprehension or comprehension of another's emotional state or condition, and that is identical or very similar to what the other person is feeling or would be expected to feel" (p. 702). Decety and Jackson (2004) propose a more explicitly cognitive model featuring three functional components that interact to produce an empathic response. These components include affective sharing that entails common representation of an experience, self-other awareness in order to differentiate the observer from the object, and "mental flexibility to adopt the subjective perspective of the other and also regulatory processes" (p. 75). Feshbach's model (1975, 1978) incorporates discrimination among affective states, perspective taking, and the modulation of an appropriate emotional response. This review of the literature regarding the emergence of affective responsiveness during infancy does not seek to arbitrate among models, but to summarize and synthesize empirical findings about the development of capacities that contribute to a range of empathic responses.

This report begins with a survey of the literature regarding qualities of infants' contributions and responses to their earliest social interactions. We focus in particular on imitation, emotion matching, and emotional contagion. These precursors of empathy impact qualities of individual interactions and thereby support the formation of strong bonds with primary caregivers. In turn, these relationships refine infants' emotion understanding and promote reciprocal responsiveness. Following a discussion of attachment and emotional attunement, we discuss research regarding infants' abilities to discriminate emotions. Responses to other people's displays of emotion are discussed and linked with prosocial behavior and the cognitive skills that support its emergence. While there is little research addressing the neurobiology of empathy during infancy, we propose links between studies of infant behavior and neuroscientific studies with older children.

Imitation, Emotion Matching, and Emotional Contagion

The observation that neonates from the first hour after birth can imitate several distinct facial gestures (Meltzoff & Moore, 1977; 1983) suggests that there is an innate mechanism that supports awareness of and responsiveness to the behaviors of other people. The ability to perform these actions upon first exposure to them suggests that the processes of observation and action are linked and possibly subserved by common structures in the brain. That this matching occurs in infants as early as 42 minutes after birth is offered as proof that the infant's capacity to imitate is neither conditioned nor shaped by adult behavior. The observation of imitative behaviors in infants aged two weeks to four months has been replicated and extended in several studies (e.g., Dunkeld, 1978; Jacobson, 1979; Burd & Milewski, 1981). "Through imitating others, the human young come to understand that others not only share behavioral states, but are 'like me' in deeper ways as well" (Meltzoff & Decety, 2003, p. 491). Imitation fosters social learning and it is a proto-communicative experience that is shared with another person. The imitation of facial expressions of emotion is especially relevant to the quality of infant-caregiver interactions and relationships. Accordingly, Field and her colleagues (Field, Woodson, Greenberg, & Cohen, 1982) identified mirrored emotional expressions on the faces of infants with a mean age of 36 hours in response to a model's display of happy, sad, and surprised facial expressions. Imitation of emotional signals is thought to strengthen identification and attachment between infant and caregiver by supporting the achievement of affective harmony.

Another emotional behavior that is evident among neonates is crying in response to the sound of another infant crying. This phenomenon might be attributed to auditory imitation, but it has only been documented in response to recorded crying and not observed crying by another infant. Crying occurs more frequently in response to human crying than to white noise or synthetic crying matched for volume, duration, and intensity of onset. The effect has been observed on the first (Martin & Clark, 1982), second (Sagi & Hoffman, 1976), and third (Simner, 1971) days after birth. Infants cry more in response to the cries of same-aged infants (mean age 18.3 hours) than to the cries of 11-month-old infants and to recordings of their own cries (Martin & Clark, 1982). Infants' responses to the sound of their own cries were characterized as interest rather than distress. This apparent ability to differentiate between self and other on the first day after birth is surprising. Given that participants became distressed and did not merely replicate the sound of another infant's crying, Sagi and Hoffman (1976) rule out the "vocal imitation" hypothesis. Gender differences in distress response among newborns (Sagi & Hoffman, 1976) parallel those observed in 4-year-olds (Levine & Hoffman, 1975). At both developmental stages, girls cried more in response to other infants' crying than boys did. Sagi and Hoffman (1976) interpret their findings as evidence of emerging empathy in newborn infants.

A more parsimonious interpretation of infants' tendency to cry in response to other infants' crying and their ability to copy certain facial expressions of emotion as early as the first day after birth (Field et al., 1982) is emotional contagion. Emotional contagion is the tendency to automatically mimic facial expressions, vocalizations, postures, and movements with those of another person and thereby to enter into an identical or similar emotional state (Hatfield, Cacioppo, & Rapson, 1994). The suggestion that mimicry automatically gives rise to a shared affective experience is supported by the finding that the intentional arrangement of facial musculature leads to a congruent arousal of the autonomic nervous system (Ekman, Levenson, & Friesen, 1983). Emotional contagion has been documented in infants as young as ten weeks of age (Haviland & Lelwica, 1987). Infants' responses to images of happy, sad, and angry faces elicited distinct responses that were characterized as matching in some conditions. Emotion matching occurred most frequently in response to mothers' expression of joy and next most frequently in response to anger. Some infants became upset in response to their mothers' displays of anger. In response to mothers' sadness, infants occasionally engaged in a behavior described as "mouthing" (p. 101), which consisted of lip and tongue sucking, and pushing the lips in and out. The authors interpret the behavior as self-soothing and relate it to a manifestation of distress in infants as young as 30 days old (Aronson & Rosebloom, 1971). The activation of distress in response to mothers' displays of sadness suggests that infants discriminate among emotions and respond to them differentially. Matching the mother's sadness with sadness would be indicative of emotional contagion, but responding to the mother's sadness with distress and self-soothing may be more complementary and congruent than identical. This minor distinction between the mother and infants' affective states anticipates the complementarity of a more mature empathic response.

Synchrony and Attachment

Infants' tendency to match automatically the emotions of their caregiver precedes the development of empathy, eliciting a shared affective experience before the infant reaches the stage at which she can take another person's perspective and respond to it appropriately. Emotion matching may also support the establishment of favorable attachment patterns by engendering emotional harmony and complementarity between mother and infant (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1969). Interactional synchrony, the extent to which a mother-infant interaction is reciprocal and mutually rewarding, "would presumably foster development of the infants' working model of mother as available, responsive, and trustworthy (Isabella, Belsky, & von Eye, 1989, p. 13). Infants whose interactions with their mothers at 1, 3, and 9 months of age were judged to be more synchronous and less asynchronous were most likely to demonstrate a secure pattern of attachment at 12 months (Isabella, Belsky, & von Eye, 1989). Ratings of

interactional synchrony require compatible or complementary states of affect and engagement rather than precise mirroring of the other person's state. The establishment of synchrony is undoubtedly effected by mothers, but there is some evidence that feedback from the infants reinforces it. Infants are attentive and responsive to their mothers' matched level of engagement at three weeks of age (Brazelton, Koslowski, & Main, 1974). Specifically, infants in dyads that achieved the most complementarity of affect and attention stayed engaged with their caregivers longer than infants in less complementary dyads. In this sense, mothers and infants both make important contributions to the quality of shared interactions.

In addition to matching affective state, emotional contagion is instrumental in the acquisition of emotion-regulating skill. In response to an infant's display of hyper-arousal, the caregiver who models downward regulation of emotion manages to calm her baby and also extends bouts of reciprocal engagement (Brazelton, Koslowski, & Main, 1974). The emotional reciprocity that results from the tendency of mother and infant to mirror each other's affective state engenders the infant's confidence in her mother's psychological availability. The shared experience of affective states helps the infant predict how her mother will behave in certain situations, thereby honing her expectations regarding her mother's availability to provide comfort. This process supports the development of the attachment relationship as well as the development of the infant's ability to understand another person's internal states (Rochat & Striano, 1999).

Infants who are secure in the expectation of caregivers' psychological availability are better able to offer emotional responsiveness to others (e.g., Sroufe, 1988; 1989). Accordingly, preschool children who demonstrated secure patterns of attachment during infancy were more responsive to their peers' distress than preschoolers with insecure patterns of attachment (Kestenbaum, Farber, & Sroufe, 1989). A study with younger children reported that securely attached 15-month-old girls demonstrated no more empathic concern in response to their mothers' distress than insecurely attached infants. However, the infants with secure attachment patterns did demonstrate more empathic response than insecurely attached infants in response to experimenters' distress simulations (van der Mark, IJzendoorn, & Bakermans-Kranenburg, 2002). These studies suggest a transfer of emotional responsiveness from caregiver-infant interactions to social interaction with peers and strangers. These findings and those described in the next section demonstrate the emergence during infancy of the components of empathy, including attunement and responsiveness to the affective qualities of interactions with others.

Emotional Attunement

Research regarding the impact of maternal depression on infants' emotional development provides further evidence that infants are sensitive to affective cues from their mothers. Depression interferes with maternal responsiveness and

attentiveness in ways that violate infants' expectations for the rhythms of interactions. By three weeks of age, infants withdraw and become distressed when mothers look at them, but present a still and unresponsive facial expression (Brazelton, Tronick, Adamson, Als, & Wise, 1975). When mothers re-engage, infants initially seem puzzled and then return to baseline levels of responsiveness. This study and subsequent research using the still-face paradigm (SFP; Cohn & Tronick, 1983; Tronick & Cohn, 1989) indicate that infants are aware of and responsive to the affective qualities of interactions with caregivers. Infants of non-depressed mothers withdraw in response to their mothers' intentional cessation of affective responsiveness. Infants of depressed mothers mirror negative affect expressed by their mothers disproportionately more than the infants of non-depressed mothers (Field, Healy, Goldstein, & Guthertz, 1990). This suggests a generalized effect of mothers' negative affect on the child's behavior during subsequent interactions.

Qualities of 4-month-olds' responses to the SFP are related to the same children's social interactions at 12 months. Specifically, infants who show less regulated responses to the still face at 4 months tend to engage in more self-oriented comforting behaviors and to show less interest and concern at 12 months in response to the video-recording of a peer who is crying (Ungerer et al., 1990). Together these findings suggest that infants' attentiveness to affective cues from others is the basis for their developing understanding of emotion and social interaction. The relation between the behavioral responses at 4 and 12 months suggests continuity in qualities of infants' attention to and competence at coping with negative emotional experience.

Cumulatively, the qualities of interactions characterize the overall caregiver-infant relationship. In turn, this relationship influences the infant's expectation regarding other relationships. Hence there is a link between qualities of infants' immediate responses to their mothers' emotional unavailability and the establishment of secure patterns of attachment. Accordingly, six-month-olds' reactions to the SFP differentiated between secure and anxious-avoidant styles of attachment at twelve months (Cohn, Campbell, & Ross, 1991). In response to their mothers' still-face display, infants who attempted to re-engage their mothers with positive affect were more likely to be securely attached at 12 months than infants whose attempts to elicit engagement were characterized by negative affect. These findings suggest that infants' responsiveness to changes in caregivers' emotional expression reflect the cumulative history of the dyad's interactions and that the still-face paradigm captures meaningful individual differences in the development of emotion-processing from four months of age. Infants are beginning to discriminate and respond to changes in the affective displays of other people at 4 months. They experience differential arousal in response to changes in other people's emotions at this age and modulate arousal by diverting their attention from social interaction that they experience as aversive. This combination of experiencing emotional

arousal while observing the emotional expression of another person and responsively regulating the vicarious emotional experience indicate development of abilities that contribute to empathy.

Emotion Discrimination & Facial Expression Processing

The still-face effect is robust despite variability in individual behavioral responses. A history of the SFP suggests that the effect is apparent in infants as young as 2 weeks of age (Adamson & Frick, 2003, citing Tronick et al., 1978). The impact of mothers' emotional withdrawal on infants less than one month old suggests that infants are responsive to changes in interactive reciprocity even before they can consistently discriminate among specific emotional expressions (Brazelton, Koslowski, & Main, 1974). Research on infants' ability to discriminate among emotions places the emergence of these skills between four and six months (Bornstein & Arterberry, 2003; Serrano, Iglesias, & Loeches, 1992). Many studies have attempted to characterize the patterns of emergence and the nature of early emotion-discriminating skills in seven-month-olds because the skills appear to be considerably better developed by this age (Kestenbaum & Nelson, 1990; Ludemann & Nelson, 1988; Nelson, 1987; Nelson & Dolgin, 1985; Nelson, Morse, & Leavitt, 1979; Kotsoni, de Haan, & Johnson, 2001). This research indicates that 5-month-olds are able to discriminate among different faces with happy expressions (Bornstein & Artberberry, 2003) and 7-month-olds can differentiate levels of happiness (Ludemann & Nelson; Nelson, Morse, & Leavitt, 1979). On the other hand, 7-month-olds look longer at fearful faces than happy faces (Nelson & Dolgin, 1985) and they take longer to habituate to fear faces than happy ones (Nelson, Morse, & Leavitt, 1979). Infants' physiological responses (event-related potentials) were distinct between presentations of happy and fearful stimuli, but not between happy and angry stimuli (Nelson & de Haan, 1996). Seven-month-olds differentiate emotional stimuli in a categorical fashion rather than as points along a continuum. They respond to changes across categorical boundaries more readily than variations within categories (Kotsoni, de Haan, & Johnson, 2001). This quality of infants' responses to the emotional states of others is adaptive for detection of macro-level changes and mood matching, which are more relevant to the quality of dyadic interaction than nuanced variation within categories of emotion. The categorical nature of early emotion recognition improves the likelihood that an infant will detect major changes in other people's affect and respond in an appropriate manner. In this way, patterns of perceiving changes in other people's affect support the development of empathic responding.

Social Referencing

While still improving their facial expression processing skills, infants begin to engage in a more cognitively sophisticated manner of responding to the emotion expressions of others. At ten months, infants begin to modify their behavior in response to their mothers' facial expressions of emotion (Feinman & Lewis, 1983). The literature on social referencing is consistent in finding that 12-month-olds pursue information from their mothers about ambiguous stimuli and that they begin to adapt their behavior in response to the interpretations of their mothers' facial expressions (Gunnar & Stone, 1984; Hornik, Risenhoover, & Gunnar, 1987; Moore & Corkum, 1994; Sorce, Emde, Campos, & Klinnert, 1985; Walden & Ogan, 1988; Zarbatany & Lamb, 1985). Infants' interactions with strangers (Feinman & Lewis, 1983); use of toys (Gunnar & Stone, 1984; Hornik, Risenhoover, & Gunnar, 1987; Walden & Ogan, 1988; Zarbatany & Lamb, 1985); and willingness to cross a visual cliff (Sorce, Emde, Campos, & Klinnert, 1985) are influenced by their mothers' facial expressions of emotion. Infants are especially responsive when mothers displayed negative emotion such as fear or disgust (Hornik, Risenhoover, & Gunnar, 1987). Factors such as the emotion mothers present and the degree to which the stimulus is considered ambiguous are related to the likelihood that an infant will engage in social referencing (Gunnar & Stone, 1984; Sorce, Emde, Campos, & Klinnert, 1985; Walden & Ogan, 1988; Zarbatany & Lamb, 1985).

Social referencing incorporates a behavioral response to a caregiver or other adult's emotional expression that is presumably mediated by the infant's interpretation of that expression. Social referencing is the infant's evaluation of non-verbal messages to glean emotional content, an efficient means for gathering essential feedback regarding the world she inhabits. Social referencing precedes empathy chronologically and from the perspective of developmental complexity. Like empathy, social referencing involves attending to another person's emotional expression in order to evaluate a set of circumstances and to determine a behavioral response. Empathy incorporates a more developmentally advanced step of orienting toward or attending to the other person's affect, its causes, and possible responses to it (Hoffman, 1982; 1983; Zahn-Waxler et al., 1992). Social referencing aims to clarify ambiguous circumstances. Empathy involves an affective sharing of experience that, in some cases, gives rise to behavior that alleviates the causes or the symptoms of another person's distress.

Prosocial Behavior

A prosocial response to another person's distress provides evidence of underlying empathy in the observer. Prosocial behavior is voluntary and presumably intended to benefit another person regardless of the agent's motive for desiring to benefit the other person (Eisenberg & Mussen, 1989). Altruistic behavior is a special case of

prosocial behavior, enacted as an end in itself rather than as a means to obtaining external rewards (e.g., Bar-Tal, 1976). A prosocial response to another person's distress is generally motivated by empathy, but is beyond the scope of empathy. Developmentally, a prosocial response reflects the ability to distinguish the object's distress from one's own, to regulate the affective arousal (distress) that results from sharing another person's distress, and to set aside one's own feelings in order to attend to the other person's concerns. Prosocial responding to another person's distress is evident as early as 12 months of age and increases across the second year (Zahn-Waxler & Radke-Yarrow, 1982).

Research regarding infants' responses to other peoples' distress between 13 and 25 months (Termine & Izard, 1988; Zahn Waxler et al., 1992) generally supports Hoffman's (1975) proposal that responses to the distress of others progress during the second year from self-oriented to other-oriented. Cross-sectional research suggests that self-distress responses decrease in frequency across the second year. Nine-month-olds tend to mirror their mothers' displays of both joy and sadness (Termine & Izard, 1988). Infants' occasional angry responses to their mothers' displays of sadness (or to their mothers' decreased responsiveness during the sadness condition) were interpreted as self-oriented. The inhibition of some play behaviors during the sadness condition relative to the joy condition was seen as evidence that the infant entered into the mother's emotional state. The infants' behavioral responses in the sadness condition also suggest a dysregulating effect of mothers' prolonged bouts (4-14 minutes) of emotional unavailability during a visit to the authors' research laboratory. One longitudinal study did not reveal significant reduction in infants' self-distress in response to other people's distress across the second year, although prosocial behavior increased between each time point (Zahn-Waxler et al., 1992; Time 1: 13-15 months; Time 2: 18-20 months; Time 3: 23-25 months). Displays of empathic concern increased between Time 1 and Time 3. These included vocalizations, gestures, and behaviors that suggested concern or similar emotional arousal. Self-referential behaviors were efforts by infants to "try on" the other person's discomfort as in examining on his own body the spot where the other person had hurt herself or pretended to hurt herself. These behaviors increased from Time 1 to Time 2, but decreased from Time 2 to Time 3. These developmental patterns held whether the infant caused or merely witnessed the other person's distress. However, infants were less likely to engage in self-referential behaviors and hypothesis testing or to demonstrate empathic concern if they had caused the other person's distress.

Developmental links between earlier and later distress-response behaviors were investigated. Self-referential behavior, hypothesis testing, and self-recognition at Time 2 were related to prosocial responding at Time 3. In this context, self-recognition refers to the child's behavior in reaction to her own image in a mirror. A scaled score reflects the extent to which the child understands information gleaned from the mirror image about herself and her environment (Bertenthal &

Fischer, 1978). Neither self-recognition, nor hypothesis testing, nor self-referential behavior was related to infants' displays of self-distress. These results support the theoretical progression toward greater other-orientation across the second year and they also suggest that the development of self-other cognition plays a role in the achievement of mature empathic responses.

Cognition and Empathy

The progress in infants' distress responses from self-oriented to other-oriented across the second year parallels cognitive developmental changes that take place during the same period. Cognitive skills that emerge during the second year that may also support the infant's ability to differentiate another person's distress from her own include self-recognition, self-other differentiation, perspective taking, and agency.

Zahn-Waxler, Radke-Yarrow, and colleagues (1992) found that ratings of self-recognition in 18-20 month-old infants were correlated with frequency of prosocial behaviors in response to other people's distress at 23-25 months. Self-recognition tasks administered in front of a mirror include the introduction of objects behind the baby that can only be found by using the image in the mirror, a rouge test that determines whether an infant understands that make-up on her image in the mirror corresponds to a smudge on her face, and a verbal inquiry about the identity of the image in the mirror. Emotions associated with self-consciousness such as embarrassment emerge during the same developmental time frame (Lewis, 1987). In a sample of 548 19-month-olds, approximately half indicated that they recognized themselves in the mirror by touching or referring to the place on their own face where their mother had surreptitiously placed a large dark blue spot (Asendorpf & Baudonnière, 1993). These authors report that self-awareness and other-recognition emerge synchronically. Bischof-Kohler (1994) observed that only children who passed a "rouge test" of self-recognition demonstrated prosocial responses to another person's display of grief.

Ungerer and colleagues (1990) challenge the claim that self-other differentiation is a prerequisite of empathic response. Only one-third of their sample of 45 12-month-olds exhibited distress in response to another person's distress. They argue that self-distress should have occurred more frequently if infants' responses were purely a matter of emotional contagion. Given that two thirds of the 12-month-olds tested did not demonstrate self-distress, the authors conclude that the advances in cognitive development that occur during the second year are not necessary for the achievement of an other-oriented response.

Infants' understanding other people's intentions and subjective stances emerge at the same time that their responses to distress increase in other-orientation. The emergence of joint attention, the ability to direct or follow another person's attention to an object or event of interest, occurs between 9 and 15 months

(Carpenter, Nagell, & Tomasello, 1998). This skill does not require reasoning about another person's mental state as much as the inclination to reference another person and the ability to gather useful information by gleaning the focus of another person's attention. Thus, joint attention skills do not provide evidence of primary intersubjectivity (Moore & Corkum, 1994), but they have been linked with the ability to share meaning and thereby to acquire language (Bruner & Sherwood, 1983; Carpenter, Nagell, & Tomasello, 1998; Flavell, 1999). At about 12 months, infants follow an adult's gaze to an object and then quickly look back to the adult's face to confirm that they have the adult's ongoing attention (Butterworth, 1991). A similar checking in occurs in conjunction with the infant's pointing and showing behaviors, which appear for the first time at the same age (Bates, 1976). Bouts of shared attention become increasingly long as infants learn to coordinate the focus of their own attention with that of adults. At this stage, infants look with increasing frequency to adults' faces during play and this occurs without elicitation by the adult (Bakeman & Adamson, 1984). When an adult looks at and labels an object while an infant attends to another object, 16- to 19-month-old infants understand that the label is associated with the object to which the adult was attending (Baldwin, 1991). Prior to conscious awareness of the adult's independent thought, the infant uses the adult's direction of attention to link a spoken label with an intended object.

Consistent with the literature on social referencing, 12-month-olds construct an expectation about adult behavior based on the adult's previous affective behavior. They expect an examiner to reach for an object that the examiner has regarded with positive affect compared to an object to which the examiner is not attending (Spelke, Phillips, & Woodward, 1995). Twelve-month-olds anticipate a model's intention as evidenced by the movement of their gaze to a goal location prior to the model's placement of an object at that location (Falck-Ytter, Gredebäck, & von Hofsten, 2006). Anticipation of object placement was evident when a person moved the object, but not when the task was performed by a mechanical arm. This suggests some understanding of agency has also been achieved by the end of the first year.

The ability of 12-month-olds to glean the planned action of a model on a video anticipates the development of Theory of Mind. Theory of Mind is the "construal of persons as psychological beings, interactors, and selves" (Wellman, Cross, & Watson, 2001, p. 655). Theory of Mind requires the understanding that other people have different perspectives and, in advanced forms, the ability to assume the other person's perspective. The ability to reason about the content of another person's thoughts is not necessary for an infant's behavior to be considered empathic. However, as with empathy, Theory of Mind involves self-other discrimination and some awareness of the internal states of others. There is evidence that these skills emerge during the second year. Whereas 14-month-olds do not give an examiner food to which she has previously responded with positive

affect, 18-month-olds do give the examiner the food she seems to prefer (Repacholi & Gopnik, 1997). Eighteen-month-olds intuit the goal of an examiner's efforts to pull apart two attached objects, even though they have not seen the examiner accomplish the intended action (Meltzoff, 1995). Understanding of other people's desires and intentions develops in the second half of the second year.

At the same time, children experience rapid vocabulary growth and they progress from single-word utterances to word combinations (e.g., Bates, Bretherton, & Snyder, 1988). Prior to the achievement of language skills, infants learn by sharing other people's affective experience and by attending to other people's affective displays. Verbal communication, especially receptive language skills, augments opportunities to learn social norms. Moreover, language acquisition and symbol use depend upon the capacity to form, retain, and access mental representations of information gleaned from other people.

A study linking parenting behavior with the advent of prosocial behavior in infants supports the notion that language capacity plays a role in the progression from self-orientation to other-orientation in infants' responses to distress (Zahn-Waxler, Radke-Yarrow, & King, 1979). Mothers' affective explanations regarding the consequences of their infants' behavior was related to infants' efforts to repair their own transgressions and to engage in altruistic behavior between 18 and 30 months. These findings suggest that experience contributes to the variability in emergence and ultimate manifestations of children's response to distress. Similarly, the finding of relationships between infants' emotional displays and those that they observe among family members suggests an influence of environment on both responsiveness and emotional expression (Zahn-Waxler, Radke-Yarrow, & King, 1979).

Links between cognition, language, family experience, and empathy imply a connection between sensitivity to affective signals and the development of social cognition. The co-occurrence of deficits in joint attention, Theory of Mind, language, and empathy among children with autism spectrum disorders (e.g., Baron-Cohen, 1989; Mundy, Sigman, & Kasari, 1990; Sigman, Kasari, Kwon, & Yirmiya, 1992) suggest a common underlying mechanism.

Neurobiology and the Development of Empathy

Our emerging understanding of the neurobiology of empathy relies primarily on research with adults. Some relevant research with infants and older children are presented here. The most promising findings in the efforts to explain neural networks that support the developmental processes described above stem from the discovery of "mirror neurons" in the ventral premotor and posterior parietal cortices of macaques. Mirror neurons discharge during the observation and performance of goal-directed hand movements (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). The possibility that observation and implementation of facial expression rely on

common circuitry offers a useful explanation for the observation that human neonates can imitate emotional expressions (Field et al., 1982), identifying and activating corresponding parts of their own bodies without a prior frame of reference. To the extent that perception is mapped onto the neural circuits associated with the part(s) of the face or body that are used in performance of the action, the target person's action is considered to be "embodied" by the observer. The embodied experience of another person's action may be instrumental in preparation to perform the same action (Gallese, Fadiga, Fogassi, & Rizzolatti, 1996) or for subsequent top-down retrieval by purely cognitive processes (Oberman & Ramachandran, 2007). Applying these concepts to the domain of emotion, the embodied representation of another person's expression of emotion would facilitate understanding of social and emotional phenomena by effecting first-hand, felt experience of observed behavior (Gallese, 2003).

Although mirror neurons were initially associated with observation and performance of goal-directed actions, the human mirror neuron system (MNS) is thought to support the embodied mapping of representations about other people's emotional experience within the observer (Gallese, Keysers, & Rizzolatti, 2004; Iacoboni & Dapretto, 2006; Niedenthal, 2007; Rizzolatti & Craighero, 2004). The mirror neuron system (MNS) is thought to play a role in theory of mind (Williams, Whiten, Suddendorf, & Perrett, 2001) and language acquisition (Arbib, 2005). There is empirical evidence that the MNS is involved in the imitation of motor activity (Iacoboni et al., 1999). An indication that the MNS is involved in social cognition is provided by the findings that this system and associated neural networks are activated in both the observation and imitation of emotional facial expressions by adults (Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003). Accordingly, the MNS also supports processes related to empathy (Decety, Michalska, & Akitsuki, 2008; Gallese, 2003; Gazzola, Aziz-Zadeh, & Keysers, 2006; Kaplan & Iacoboni, 2006; Pfeifer, Iacoboni, Mazziotta, & Dapretto, 2008).

Several functional neuroimaging studies with adults indicate that the observation of another person's pain and the first-hand experience of pain are subserved by similar neural networks. Recruited networks involve those associated with the affective (Gu & Han, 2007; Jackson, Meltzoff, & Decety, 2005; Jackson, Brunet, Meltzoff, & Decety, 2006; Lamm, Batson, & Decety, 2007; Moriguchi et al., 2007; Morrison, Lloyd, di Pellegrino, & Roberts, 2004; Morrison, Peelen, & Downing, 2006; Saarela et al., 2007; Singer et al., 2004) and sensory (Avenanti, Bueti, Galati, & Aglioti, 2005; Benuzzi, Lui, Duzzi, Nichelli, & Porro, 2008; Bufalari, Aprile, Avenanti, Di Russo, & Aglioti, 2007; Lamm, Nusbaum, Meltzoff, & Decety, 2007; Moriguchi et al., 2007) aspects of pain. Developmentally, the earliest evidence of these phenomena comes from a study with children between the ages of 9 and 12 years (Decety, Michalska, & Akitsuki, 2008). As with adults, the overlapping neural circuits recruited during the observation and the direct experience of pain in children include the insula, the somatosensory cortex, the

anterior mid-cingulate cortex, periaqueductal gray, and the supplementary motor area.

Findings from several studies suggest that the MNS is functional during infancy (for a review, see Lepage & Theoret, 2007). Shimada and Hiraki (2006) used near infrared spectroscopy (NIRS) to compare manipulation of an object and the observation of the same activity between 6-7-month-old infants and adults. Infants recruited the same motor cortical areas during the observation and performance phases of the experiment. Whereas adults' neural activation differed between observations of live and video-recorded presentations of manual activity, infants' similar neural responses suggest that they did not make the same distinction. These results were interpreted to mean that the MNS is present at birth, but improvement in the understanding of the nature of visual stimuli over time indicates that refinement of the MNS occurs with experience and cognitive development.

Electroencephalography (EEG) was used to record similar sensorimotor activation patterns during observation and performance of a drawing task by a 36-month-old child (Fecteau et al., 2004). The toddler's activation patterns resembled those observed in adults (Tremblay et al., 2004). Scalp EEG was used to measure *mu* rhythm amplitude during observation and performance of manual grasping activity in children between 4 and 11 years of age (mean age = 99.3 months; Lepage & Theoret, 2006). *Mu* rhythm amplitude decreased relative to baseline measurement during the observation and performance of the grasping action. Reduction of the *mu* rhythm is thought to reflect the recruitment of neurons in the fronto-parietal circuit involved in sensorimotor processes. *Mu* rhythm modulation relates to MNS function as both observation and performance reduce its amplitude in the sensorimotor cortex.

Our own work with 10-year-olds indicates that children's self-reported ability to empathize is correlated with activity in the MNS (pars opercularis in the IFG) and in the amygdala, a region associated with emotion representation, during the observation and imitation of emotional expressions (Pfeifer et al., 2008). In typically developing children with a mean age of 12.38, we also recorded activation in the pars opercularis in the IFG during imitation and observation of emotional facial expression (Dapretto et al., 2006). Activation in this region was significantly reduced in age-matched children with an autism spectrum disorder (ASD) as has been reported in adults with ASD (Nishitani, Avikainen, & Hari, 2004). These differences in activation pattern are consistent with evidence of deficits in empathic responding among infants (Charman et al., 1997), preschoolers (Bacon et al., 1998; Dawson et al., 2004; and Sigman et al., 1992), and adolescents (Yirmiya, Sigman, Kasari, & Mundy, 1992) with ASD. These findings support the claim that MNS dysfunction is responsible for deficits in interpersonal understanding and empathy that are hallmarks of ASD (e.g., Iacoboni & Dapretto, 2006; Oberman et al., 2005).

As conceptualized, the MNS helps to explain the ability of neonates to match other people's behaviors, which they cannot feel, with their own actions, which they cannot see (Meltzoff & Decety, 2003). Prior to the identification of mirror neurons in macaques, Meltzoff and Moore (1977) proposed that imitation in neonates was accomplished by a representational mechanism that matches visual input with its proprioceptive equivalent. The MNS is also useful in explaining emotional contagion, specifically the suggestion that mimicry of facial expression occurs automatically (Hatfield et al., 1994). The likelihood that the MNS is operative during infancy helps to explain the finding that 9- (Termine & Izard, 1989) and 12-month-olds (ZahnWaxler et al., 1992) become distressed when they observe someone hurting herself. Research indicating that the activation of the MNS varies according to context and relevance of the visual stimuli to the research participant (Cheng, Meltzoff, & Decety, 2007) suggests that its function is influenced by experience and modulated by cognitive processes. This finding is consonant with the observation that behavioral responses to other people's distress vary with experience (Zahn-Waxler, Radke-Yarrow, & King, 1979).

Decety and Jackson (2004) have reviewed the literature regarding the neurobiology of empathy and its component features. These authors emphasize the role of shared representations of emotion, subserved by the MNS, working in concert with several cognitive components of empathy including self-recognition, other-awareness, cognitive control, and perspective taking. They propose that empathy encompasses shared representation of an action or experience, the maintenance of a clear distinction between self and other, and regulation of the shared emotion. Cognitive control and executive function are instrumental in regulating vicarious emotion and personal distress. Accordingly, the activity of the MNS is complemented by other neural circuits that subserve cognitive processes involved in the calibration of the observer's affective and behavioral responses to another person's distress. For instance, the temporoparietal junction (TPJ) is involved in several cognitive functions discussed above. These include processes involved in distinguishing between one's own action and actions performed by others (Blakemore & Frith, 2003; Jackson & Decety, 2004); Theory of Mind (Apperly, Samson, Chiavarino, & Humphreys, 2004; Saxe & Wexler, 2005); and judgments concerning agency (Farrer & Frith, 2002; Leube et al., 2003). The TPJ receives input from the lateral and posterior thalamus, visual, auditory, somesthetic, and limbic areas and is connected to the PFC and temporal lobes (Decety & Meyer, 2008).

The MNS may 'automatize' the reflection of other people's emotional expression, which in turn provides feedback and stimulates the arousal of the observer's autonomic nervous system (Ekman, Levenson, & Friesen, 1983). Experience influences the cognitive processes that interpret events and motivate a behavioral response. The MNS may catalyze the autonomic response to an object's state (Preston & de Waal, 2002), but improvement in cognitive abilities influences

the interpretation of circumstances, the infant's own experience of the circumstances, and the nature of the response that is recruited (Schachter & Singer, 1962). Thus, all of the developmental steps involved in reflection, discrimination, and reaction to another person's affective behavior contribute to empathy. The automaticity of the process cumulatively builds expertise in recognition and interpretation of social and emotional phenomena. The resulting understanding enables a top-down empathic process wherein cognition of an imagined or described event maps onto previous embodied experience, direct or observed, and gives rise to an affective response.

Summary and Future Directions

Empathy is associated with altruistic and prosocial behavior in response to the distress of others (Zahn-Waxler & Radke-Yarrow, 1982; Zahn-Waxler, Radke-Yarrow, Wagner, & Chapman, 1992). It is fundamental to the fine-tuning of social interaction as it engenders felt understanding of other people's experience. Empathy has been associated with the quality of interpersonal relationships (Kestenbaum, Farber, & Sroufe, 1989), social competence (Eisenberg, 2000; Saarni, 1997), and moral reasoning (Hoffman, 2000). It is both driven by and essential to sociality (Carter, Harris, & Porges, 2009), fundamental to successful functioning in groups, and therefore adaptive for survival (Darwin, 1899). Conversely, impairment in empathic processes are associated with adverse outcomes such as autism spectrum disorders (e.g., Sigman et al., 1992), conduct disorder (Frick & Ellis, 1999), and psychopathy (Soderstrom, 2003). Continued research into the neural mechanisms that subserve the early development of empathic processes is essential to furthering our understanding of these disorders and improving outcomes among people affected by them.

This compilation of findings regarding the precursors and components of empathy suggests various means for addressing revealed gaps in the understanding of this construct. Longitudinal examination of responses to other people's distress repeated at short intervals between 10 and 24 months would improve characterization of the maturation of responses from self-distress to concern for others. The use of eye-tracking technology would provide detail regarding the duration and modulation of infants' attention to a distressed person and the cause of distress. Pupilometry and heart rate data can help to gauge autonomic arousal in response to another person's distress. Neuroscientific technologies such as electro-encephalography (EEG) and near infrared spectroscopy (NIRS) could be used in conjunction with infant behavioral methods to confirm developmental continuity with findings regarding the neural circuitry involved in empathic processes among older children. An effective research design for such a study would include infants at risk for impairment in empathy (Barnwell et al., 2009; Hutman et al., 2009). Behavior, gaze patterns, neural activity, and genetic data can be compared between

a group of infants at risk for autism (full siblings of children with autism) and a group of low-risk infants with no family history of the disorder. At the very least, these lines of research should provide valuable new insights about the nature and development of empathy in humans. Beyond that, they might even contribute to the improvement of interpersonal understanding and cooperation.

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