Experimental protocols for investigating relationships among mother-infant interaction, affect regulation, physiological markers of stress responsiveness, and attachment

Kathie Nichols, PhD
György Gergely, PhD
Peter Fonagy, PhD

Gergely and Watson's (1996) social biofeedback theory of parental affect mirroring applies the conditional probability model of contingency perception to parent-child interactions. Infants are first evaluated at birth on neurological and temperament measures. Infants are also evaluated at 6 and 12 months on tasks that study social interactional determinants, infant attachment, and physiological reactions. The Strange Situation is completed at 12–15 months of age. The authors describe how the combination of these experimental and observational procedures allows specific developmental hypotheses to be investigated about the quality of contingent parental affect regulation, sensitivity to internal states, and security of attachment. (Bulletin of the Menninger Clinic, 65[3], 371–379)

The Menninger Infant Lab has been established to continue the systematic investigation of previous work on affect regulation and attachment security started in labs with György Gergely at the Hungarian Academy of Sciences and Peter Fonagy at University College London. Some paradigms have been used previously, some are im-

This article is based on a presentation at a symposium on “Contingency Perception and Attachment in Infancy” held at The Menninger Clinic, Topeka, Kansas, September 8–9, 2000.

Dr. Nichols is a coinvestigator in the Child and Family Center, The Menninger Clinic. Dr. Gergely is a consultant to the Child and Family Center, The Menninger Clinic, and head of the Institute for Psychology, Hungarian Academy of Sciences, Budapest. Dr. Fonagy is director of the Child and Family Center and the Clinical Protocols and Outcomes Center, The Menninger Clinic; Freud Memorial Professor of Psychoanalysis, University of London; and director of research, Anna Freud Centre, London. Correspondence may be sent to Dr. Nichols at The Menninger Clinic, PO: Box 829, Topeka, KS 66601-0829; e-mail: nicholks@menninger.edu. (Copyright © 2001 The Menninger Foundation)
provements, and others are pilots. The methods include experimental, observational, and physiological investigation of the nature of early affect regulation and the development of attachment security.

Infants' initial capacities to regulate their own emotional reactions are extremely limited, and they must learn affective self-regulation from interactions with their caregivers. However, infants show an initial species-specific sensitivity to human facial/vocal displays and an innate propensity to engage in affective interactions with their caregivers (see Gergely, in press). Gergely and Watson (1996) have recently proposed that contingent parental reflections of the infant's negative expressed emotions serve a direct affect-regulative function by providing the baby with a positively arousing experience of contingent causal control over the parent's affect-reflective displays.

Classical views have assumed infants to be initially more sensitive to internal than to external stimuli (Bruner, Olver, & Greenfield, 1966; Mahler, Pine, & Bergman, 1975). Recent evidence indicates that a switch in sensitivity from internal stimuli to external stimuli occurs at a very early age. Prior to 3 months of age, infants are most aroused by the perfect contingency inherent in self-actions allowing them to differentiate self from others (Watson, 1985). At about 3 months, social responses that are most effective in facilitating affect regulation are those that reflect back to infants their own behavior at a pace and level of activity that is in tune with their behavior. Gergely and Watson (1996) hypothesized that in early infancy the perceptual system is set with a bias to attend to and explore the external world; hence infants initially are more sensitive to exteroceptive cues in learning. Along the same lines, Colombo, Mitchell, Coldren, and Atwater (1990) reported that exteroceptive cues (external noncontingent stimuli) are more accessible than interoceptive cues (internal and perfectly contingent stimuli) in 6- and 9-month-old infants.

The perceptual shift in attention to exteroceptive stimuli, preference for facial feedback by caregivers, and innate tendency to express emotions automatically by 3 months come together and lay the foundation for the development of affect regulation in the infant. Through the first year, infants are primarily dependent on their caretaker's affect regulative interactions in developing their own emotional self-regulation. According to Gergely and Watson's (1996) theory of affect-mirroring, the imitative facial and vocal responses of the caretaker play an important causal role in the regulation of infants' distressed affect states. Infants' self-regulation of emotions is promoted or hampered by the quality of their caretak-
ers' affective communicative actions. An infant's detection of a high degree of contingent relationship between the caretaker's affect-reflecting display and the infant's emotion-expressive behavior is positively arousing for the infant and, as such, contributes to on-line regulation of affect states.

According to Gergely and Watson (1996, 1999), contingent empathic reflections of the infant's affect expressions also serve a sensitization and representation building function, which results in the establishment of affective self-states that thus become cognitively more accessible, leading to increased emotional self-awareness and control. This affective learning process can be integrated with conceptualizations of the biosocial (physiological and interactional) nature of the mother-infant attachment system (Bowlby, 1969). In current attachment theory, the attachment system is conceived of in terms of regulation of emotions (Carlson & Sroufe, 1995), and security of attachment has been associated with the parent's ability to successfully regulate the infant's emotional states. Secure attachment is predicted by various measures of caregiver responsiveness and synchrony of dyadic interaction at the home observed during the first year (e.g., Ainsworth, Blehar, Waters, & Wall, 1978).

Given that physiological processes are integral to emotions and their regulation, identifying and investigating the role of emotion-relevant physiological systems in the development of affect regulation seems highly important. Most behavior is built on a foundation of physiological regulation. The parent-child interaction is no exception. Consequently, a relationship among physiological reactivity, cognitive processing, and social interaction would be expected. Measures such as heart rate, vagal tone, and salivary cortisol yield much information about complex behaviors such as crying, cognitive processes, and social interactions (Doussard-Roosevelt & Porges, 1999; Gunnar, 1992; Kagan & Snidman, 1991). Consistent relationships have been found for a number of behaviors and physiological reactions. Heart rate is an immediate response related to current physical state or arousal (Stroufe & Waters, 1977). Higher levels of vagal tone are usually associated with processing of information and attention, whereas lower levels of vagal tone may be more indicative of avoidant strategies and blunting of emotional interaction (Porges, 1992). Crying increases heart rate and cortisol production, whereas smiling and cooing decrease heart rate and cortisol production while increasing vagal tone (Spangler & Grossman, 1993). Insecurely attached children may experience physiological hyperarousal and cortisol secretion. Exploration decreases as distress increases when infants are separated from their mothers. The mother's return reduces dis-
tress and the child returns to play. This “secure base behavior” modulates not only the infant’s behavior but also the physiological reaction to the stress of separation. Studies indicate that even insecurely attached children are soothed physiologically by the presence/return of the attachment figure (Gunnar & Donzella, 1999).

While the caretaker’s ability to engage in affect-reflective mirroring interactions may play an important role in affect regulation, the infant’s innate temperament is also likely to have a significant influence on this process. The salience of behavioral traits on temperament in involuntary stress responses is often overlooked. There is increasing evidence that behavioral inhibition is correlated with changes in autonomic nervous system activity. Kagan and Snidman (1991) suggest that extremely inhibited children have a lower threshold in the amygdala for the activation of stress-sensitive physiological systems in response to novel or strange events. Behaviorally inhibited children are described as more “stress reactive.” It could be argued that this physiological arousal (interoceptive cues) in inhibited children interferes with emotional relatedness and communication in the parent-child dyad (exteroceptive cues), further adding to difficulties in self-regulation. Infants with inhibited temperaments experience higher reactivity (e.g., more crying, greater irritability) and higher levels of stress (more difficult to soothe). Research with older children indicates that higher physiological arousal interferes with cognitive processes (Dodge, 1993). In inhibited stress-reactive infants, these interoceptive cues (physiological arousal), at least in early infancy, may interfere with the processing of exteroceptive cues of affect-reflective displays by the parent.

The hypothalamic-pituitary-adrenocortical (HPA) axis has figured prominently in research on stress and coping in both animals and humans. Activity of the HPA system plays a major role in stress resistance, affecting energy metabolism, learning and memory, and emotional responding. At birth, the HPA axis is highly reactive, but reactivity becomes better modulated over the first year (Gunnar, 1992). In addition, increased cognitive abilities, such as the ability to remember specific events, may reduce reactivity of the HPA system by reducing the novelty component to cortisol responses. Behavior becomes more organized and, with the development of secure attachments, the presence of secure attachment figures inhibits cortisol elevations to many stressors.

Research on the HPA system indicates that the availability of coping resources and effective coping behavior play a major role in determining whether potentially threatening events stimulate elevations in cortisol over baseline values (Gunnar, Marvinney, Isensee, &
Fisch, 1988). A secure attachment provides the infant with coping resources that allow the infant to manage novel situations that might otherwise induce excessive stress responses.

Constantly changing cognitive and behavioral efforts are needed to manage specific external and internal demands that tax or exceed the resources available to the infant (Compas, Connor, Saltzman, Thomsen, & Wadsworth, 1999). Exposure to stress early in life, especially intermittent stress, has been shown to have a permanent physiological effect on the brain.

Current research using physiological measures such as cortisol indicates that stable and reliable results can be obtained by 6 months of age. Circadian rhythms are present in most endocrine functions, including the HPA axis. Although the presence of circadian rhythm of adrenocortical function in children and adults is well documented, there are few data about the age of appearance of circadian rhythms in cortisol secretion. The few studies that have examined this issue reported the appearance of typical adult daily variations in circadian rhythms in infants from 3 to 6 months. A recent study indicated that 55% of infants had established and maintained circadian rhythms by 2, 4, and 8 weeks (Santiago, Jorge, & Moreira, 1996). Another study suggested that the development of circadian patterns in adrenocortical activity parallels the development of sleeping and feeding patterns and is related to maternal adrenocortical activity (Spangler, 1991). Other research (Gunnar, Brodersen, Krueger, & Rigatuso, 1996; Lewis & Ramsey, 1995) notes decreases in cortisol reactivity between 2 and 6 months, with continuing decreases from 6 to 15 months. This continued decrease may be related to the changes in sleep-wake patterns. These issues have influenced our decision to collect salivary cortisol beginning at 6 months to allow for more stable and reliable reactivity levels in the infants.

Gergely and Watson's (1996) social biofeedback theory of parental affect-mirroring applies the conditional probability model of contingency perception (Watson, 1972, 1994) to affect-regulative interactions in which parents modulate their infant's affective state by partially reflecting back their baby's facial and vocal emotions. It is proposed that infants with a history of successful affect-regulative mirroring interactions will develop a heightened sensitivity to proprioceptive facial cues in learning, due to the sensitization effect of social biofeedback. A history of contingent affect-reflective parental interactions is hypothesized to contribute to the development of attachment security in infancy. This view predicts a correlation between infant security of attachment and contingent affect-reflective parental responses during facial interactions.
A current Menninger study

The purpose of several ongoing studies in the Menninger Infant Lab is to provide new and reliable empirical evidence about the early development of affect regulation and attachment security in infants. To illustrate briefly, a description of a current longitudinal study is provided. Infants are examined across the first year of life, beginning with a neonatal behavioral assessment of cognitive processing, attachment indicators, and cortisol reactivity during the first year. Three measures are used for this assessment: the Neonatal Behavioral Assessment Scale, the Mirror Interaction Situation, and the Discriminative Learning Task.

*The Neonatal Behavioral Assessment Scale (NBAS)*
This scale (Brazelton & Nugent, 1995) is completed with the infant within the first 2 months. It is a comprehensive examination of neonatal behavior that includes 28 behavioral items, an assessment of the infant’s neurological status on 18 reflex items, and 7 supplemental scales designed to capture the range and quality of behavior of high-risk infants. The purpose of including the NBAS is to have baseline neurological and temperament measure to control for initial individual differences that might exist between the infants.

*The Mirror Interaction Situation (MIS)*
Gergely and Watson (1996) hypothesize that a central function of parental affect-mirroring is to provide a sensitization training (mediated by contingency detection), which results in a gradual increase in the infant’s capacity to perceive and monitor the interoceptive stimulus correlates of his or her facial expressions. The MIS was designed to investigate the role of facial and vocal contingent reactions in affect-regulation by separating such forms of distal interaction from proximal contact in a modified version of a classical, mildly stressful situation, the Still-Face procedure (Tronick, Als, Adamson, Wise, & Brazelton, 1978). In the MIS, parent and infant are seated next to each other facing a one-way mirror. A screen that separates parent and infant blocks direct physical contact between them. They are free to interact facially and vocally with each other’s live mirror image. The MIS involves three 2-minute phases: (1) an initial baseline phase of free interaction, followed by (2) a mildly stress-inducing phase during which the parent puts on a neutral, motionless “still-face,” after which (3) a final free interaction phase of “recovery” provides an opportunity for the pair to reengage in affect-regulative facial and vocal interactions.

The MIS presents the infant with a choice of using two different
types of stimulus sources of self-generated contingencies. Infants can either attend to their own self-image in the mirror (providing a perfectly response-contingent stimulus display), or they can orient toward their parent's image in the mirror, the degree of contingent relatedness of which varies as a function of parental attunement and the established interactive style of the dyad.

The Discriminative Learning Task
This task has been designed to gain new insight into the social-interactional determinants of the development of sensitivity to internal self-states. When the infant (after completing the NBAS at 0–2 months) returns at the 6-month point, a discriminative learning task measuring sensitivity to proprioceptive versus exteroceptive facial cues is administered through a computer program. The facial gesture of mouth opening (a component of the basic emotional expression of "interest" [Ekman, Friesen, & Ellsworth, 1972] is used as the discriminative stimulus cue. The infant will also return at 12 months to participate again in the discriminative learning task and the MIS. Approximately 2–4 weeks later, the child and parent will return and participate in the Strange Situation (Ainsworth et al., 1978) to obtain a standard measure of attachment classification.

The development of stress responses and their regulation is important to understanding behavioral traits and cognitive processes in infancy. Salivary cortisol will be collected from each infant as an objective measure of infant reactivity before and after the MIS task at both 6 and 12 months, as well as before and after the Strange Situation on the final visit. This physiological measure will allow comparison between the observational and experimental information gathered on affect regulation and attachment security on a more objective level. For example, observation of the avoidant infant may indicate that the infant experiences less stress under parental still-face due to the previous habitual experience with parental rejection. To evaluate stress levels being experienced by infants, we will collect pre- and postcortisol samples to provide an objective and independent measure apart from observed behavioral reactions.

Conclusion

The combination of these seminaturalistic observational and experimental tasks and the concomitant physiological measures (such as salivary cortisol) in a longitudinal design will allow us to test specific developmental hypotheses about the early social-interactional as well as innate temperamental determinants of the development of affect-
regulation during the first year of life. For example, this approach will enable us to assess the hypothesized relationships between the quality of contingent parental affect-regulative “mirroring” interactions and the development of sensitivity to internal self-states, on the one hand, and security of attachment, on the other.

References
Experimental protocols


