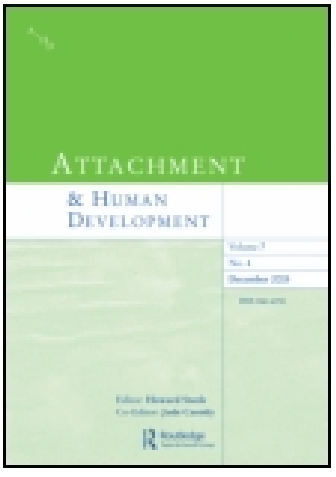

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How does microanalysis of mother–infant communication inform maternal sensitivity and infant attachment?

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Microanalysis research on 4-month infant–mother face-to-face communication operates like a "social microscope" and identifies aspects of maternal sensitivity and the origins of attachment with a more detailed lens. We hope to enhance a dialogue between these two paradigms, microanalysis of mother–infant communication and maternal sensitivity and emerging working models of attachment. The prediction of infant attachment from microanalytic approaches and their contribution to concepts of maternal sensitivity are described. We summarize aspects of one microanalytic study by Beebe and colleagues published in 2010 that documents new communication patterns between mothers and infants at 4 months that predict future disorganized (vs. secure) attachment. The microanalysis approach opens up a new window on the details of the micro-processes of face-to-face communication. It provides a new, rich set of behaviors with which to extend our understanding of the origins of infant attachment and of maternal sensitivity.

Keywords: microanalysis of mother-infant interaction; infant attachment; maternal sensitivity

Microanalysis research on 4-month infant–mother face-to-face communication can contribute to our understanding of maternal sensitivity and the development of infant internal working models in the origins of infant–parent attachment (Ainsworth, Blehar, Waters, & Wall, 1978). Microanalysis operates like a "social microscope," identifying "subterranean" rapid communications, which are often not quite perceptible in real time. This approach offers the possibility of identifying aspects of maternal sensitivity and the origins of attachment with a more detailed lens.

In this paper we review two research paradigms, the microanalytic approach to mother–infant face-to-face communication (dubbed "microanalysis approach") and maternal sensitivity and emerging working models of attachment, in the spirit of an enhanced dialogue between the two. Ainsworth and colleagues set the stage for relating 4-month infant–mother communication to 12-month attachment by coding mother–infant face-to-face interaction and predicting outcomes in the Strange Situation in a study by Blehar, Lieberman, and Ainsworth (1977).

The prediction of infant attachment from microanalytic approaches and their contribution to concepts of maternal sensitivity are presented. We describe one microanalytic study by Beebe and colleagues (Beebe et al., 2010) which documents new communication patterns between mothers and infants at 4 months that predict future disorganized

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(vs. secure) attachment. These findings provide one basis for describing emerging infant-with-mother working models of disorganized attachment, procedurally organized expectancies of action sequences, as early as 4 months. In describing the nature of the mother's communication with her infant on a moment-to-moment basis, microanalysis research can also refine our understanding of maternal sensitivity.

These two approaches, maternal sensitivity and microanalysis of face-to-face communication, share a central underlying construct: that the patterning of mother–infant interaction is central to infant social-emotional development. However, the theory, terminology, methods of behavioral coding, and statistical approaches differ considerably.

Ainsworth's construct and assessment of maternal sensitivity

Maternal sensitivity is one of the central constructs of attachment theory and research. Ainsworth's sensitivity construct derives from observations of 26 mother–infant dyads who participated in the Baltimore study and were visited at home for 4 hours every 3 weeks from 3 to 54 weeks. The visitor-observers took detailed notes of the infants' interactions with their mothers and anyone else present. The notes were subsequently audio-recorded and transcribed into narrative records. Based on the 9–12 month narrative records, Ainsworth developed a Maternal Sensitivity Scale and three additional scales (cooperation, accessibility, and acceptance). Each scale provides an extensive definition of the underlying construct as well as descriptions of each scale-point.

The definition of Maternal Sensitivity has four essential components: awareness of infant signals, accurate interpretation, appropriate response, and prompt response. In the scale, awareness of infant signals is described as follows: "In play and social interaction, the mother responds appropriately to her child, does not over-stimulate him by interacting in too intense, too vigorous, too prolonged or too exciting manner. She can perceive and accurately interpret the signs of over-excitement, undue tension, or incipient distress and shift the tempo or intensity before things have gone too far. Similarly, she is unlikely to under-stimulate the child, because she picks up and responds to the signals he gives when he is bored or when he wants more interaction than has heretofore been forthcoming" (Ainsworth, Bell, & Stayton, 1974, p. 128). The coder has to learn the gestalt of Ainsworth's formulations concerning sensitivity. Maternal sensitivity ratings were strongly correlated with infants' classifications in the Strange Situation at 1 year (Ainsworth et al., 1978).

Subsequent empirical studies more broadly connecting global measures of maternal sensitivity to infant attachment security/insecurity have not been as robust as would be predicted from Ainsworth's findings. The meta-analysis by De Wolff and Van IJzendoorn (1997) found that maternal sensitivity and infant–mother attachment were related but with a modest effect size, concluding that "sensitivity is important but not an exclusive condition of attachment security" (p. 571). Thus despite important recent progress in understanding the origins of 12-month attachment, a full understanding of the mechanisms of attachment formation prior to 12 months is still lacking (Hofer, 1994; Lyons-Ruth, Bronfman, & Parsons, 1999; Madigan et al., 2006; Tarabulsy, Tessier, & Kappas, 1996).

Less well known, Blehar et al. (1977) also used the Baltimore narrative transcripts described above to analyze early face-to-face interactions. As the authors explained: "little attention has been given to the behavior of mothers when in face-to-face interaction with their infants" (Blehar et al., 1977, p. 183). Citing Daniel Stern (1974), they suggested "the possibility that individual differences in the patterning of maternal behavior [that] might lead to distinctive patterns of infant behavior, especially as the goal of these interactions is

the regulation of stimulation so that an affectively positive level of arousal in the infant is maintained" (Blehar et al., 1977, p. 183). Stern (1974, p. 402) had argued: "By providing a more fine-grained view of the instant-by-instant interactive events which make up the mother–infant relationship, we may be in a better position to modify and expand current working theories on the nature of developing object relations or attachments."

Blehar et al. (1977) reported on 732 episodes of face-to-face interaction extracted from the narrative records of the home visits at 6, 9, 12, and 15 weeks. Coders were blind to the infant's subsequent attachment classifications. Both maternal and infant behaviors were coded; most codes required qualitative judgments (such as maternal pacing in line with the infant's state of arousal) rather than pure counts of behavior. While broader and less specific, these codes convey some of the essence of the more detailed codes used in microanalysis, as we will see below.

At 12 months, infants identified as securely (vs. insecurely) attached to their mothers in the SSP had been more responsive in early face-to-face encounters, and their mothers had been more contingently responsive and encouraging of interaction (Blehar et al., 1977). Contingent responsivity was judged coding from the narrative records. Infants later identified as anxiously (vs. securely) attached were more unresponsive and their mothers were more likely to be impassive or abrupt. Securely (vs. insecurely) attached infants were more positively responsive to their mothers than to unfamiliar figures in face-to-face interactions. Blehar et al. (1977, p. 193) concluded: "It would be good to replicate this study using recording methods that permit more fine-grained measures than those we could employ." The microanalysis research reported in this paper, now nearly 50 years later, is in this tradition.

Theory and research informing a microanalysis approach to mother–infant face-to-face communication

Microanalysis of mother–infant face-to-face communication in the first months of life is concerned with the communication process itself: how does it work, how does it facilitate development, and what are the early communication disturbances and their developmental consequences? This approach has been used to document the effects of maternal distress, such as depression and anxiety, on mother–infant communication and to predict infant social, cognitive, and attachment outcomes. Compared to an attachment approach, there are important differences in theory as well as in the approach to coding and data analysis.

Brazelton, Trevarthen, and Stern all began fine-grained studies of mother–infant face-to-face communication around the same time. Daniel Stern published his first paper in 1971; Colwyn Trevarthen in 1974; and T. Berry Brazelton, Barbara Kozlowski, and Mary Main in 1974. Edward Tronick, Brazelton's student, soon became a leading figure, as did Lynne Murray, Trevarthen's student; as well as Alan Fogel, Tiffany Field, Michael Lewis, Jeffrey Cohn, among others. Beatrice Beebe was Daniel Stern's student. Currently Ruth Feldman and Daniel Messinger (Alan Fogel's student) have become prominent in this field. Although Louis Sander did not study face-to-face communication, his systems view of self- and mutual regulation, informed by biological systems views (particularly those of Van Bertalanffy and Weiss) were extremely influential. Sander (1977) argued that both partners generate complexly organized behavior that must be coordinated in a bi-directional process of mutual modification. Ethology, the study of behavior in its natural habitat, also influenced the careful, descriptive, microanalytic approach. Three figures in this field have also been psychoanalysts: Sander, Stern, and Beebe. Lyons-Ruth is also active in psychoanalysis. Psychoanalysis has a longstanding interest in the mother–infant relationship, and together the two fields of infant research and psychoanalysis have

generated a creative synergy enriching to both (see for example Beebe & Lachmann, 2002; Stern et al., 1998).

In the study of face-to-face communication, mother and infant are seated face-to-face. Two cameras, one on each partner's face, generate a split screen view. The mother is instructed to play with her baby as she would at home, but without toys. Interactions videotaped when infants are approximately 4 months old have generated the majority of the research. This research spans infant ages 2–9 months. Earlier than 3–4 months, infants have difficulty regulating their arousal sufficiently to sustain face-to-face engagement. They easily become fussy, or they go to sleep. By 3–4 months, infants become easier subjects and sustain face-to-face engagement. Moreover, 3–4 months marks the flowering of infant social expressive display. Although all of the facial expressions are myelinated before birth, the full open-mouth "gape smile," the apex of positive affect, is not routinely seen until this age. Long periods of sustained, mutual gaze also become reliable at this age.

Face-to-face communication is extremely rapid. Much of it is out of awareness. Moreover, in real time, it is often extremely difficult to discern the exact sequence of behaviors. For example, watching a particular mother–infant pair in real time, Beebe's students often insist that the infant broke eye-contact and looked down at the moment he did because the mother had moved her finger in toward the infant's belly, about to poke; the interpretation is that the mother's movement in to poke influenced the infant's gaze down. But microanalysis reveals the opposite order: the infant broke eye-contact and looked down first, the mother reacted with some facial tensing, and then she lightly poked the infant's belly, as if to say, "Come back" (see Beebe & Lachmann, 2013). In this viewing, the infant looking down influenced the mother to poke.

This vignette illustrates a central proposal in the face-to-face interaction literature, that communication is reciprocal and two-way. Each individual affects the behavior of the other, moment-by-moment. The data analysis attempts to pry apart each person's effect on the other, to see if this two-way communication is in fact operating.

Coding approach

Compared to coding from narrative records, the microanalysis coder's task is entirely different. Behavior is coded with a small time unit, generally one second (or smaller). The coder has to learn to see or hear very small shifts and subtle nuances in behavior. For example, in coding infant vocal affect, Beebe et al. (2010, 2011) distinguished high positive, neutral/positive, no-vocalization, fuss-whimper, angry-protest, and cry. Many of the qualities of behavior being coded, such as affectionate vs. static touch vs. jiggle, require repeated viewings in slowed time. Much of what is coded cannot be accurately grasped with the naked eye, a key difference between microanalysis of behavior vs. coding maternal and infant behavior, let alone global sensitivity, from narrative records. Careful judgment is involved in both. However, the behavioral referent is very narrow in microanalysis, such as the judgment as to whether gaze is on or off the partner's face. The judgment in coding from narrative records usually has a broader referent, such as the determination of appropriate maternal pacing of the interaction. Thus, microanalytic second-to-second assessments reveal new information.

Communication as "process" and as "content"

The *process* of communication (the moment-to-moment temporal process of behavior across time) is distinct from its *content* or qualitative features (such as affective valence,

rates of gaze aversion, or intrusive touch). Microanalysis research considers both. In contrast, most attachment research is based on coding of qualitative features of behavior, such as infant resistance to the parent manifested by fussing or crying, without being able to be comforted.

Mutual regulation

Using a "wide-angle lens," both paradigms construe mother and infant as each influencing the other, a bi-directional, reciprocal, mutual regulation process. Although Ainsworth focused more on the mother's influence, she also addressed aspects of mutual adaptation.

Mutual regulation is not necessarily equal or similar. The mother brings her own genetic and temperamental variations, her attachment history, and states of mind, such as depression or anxiety. The infant brings variations in regulatory capacity and temperament factors such as sensory sensitivities.

Using a "narrow-angle lens," the definition of mutual regulation shifts. Microanalysis approaches generally define mutual regulation in terms of how each partner may "influence" the other moment-to-moment. "Influence" is defined as the degree to which one individual's prior behavior predicts the partner's current behavior. The terms regulation, influence, coordination, and contingency are used here interchangeably. Greater emphasis on infant coordination with mother, as well as maternal coordination with infant, has been important in the longitudinal prediction of infant attachment outcomes from microanalysis of mother–infant interaction (Feldman, 2007; Fogel, 1992; Jaffe, Beebe, Feldstein, Crown, & Jasnow, 2001; Tarabulsy et al., 1996). This focus on both partner's contribution with micro-analytic second-to-second assessments reveals new information that narrative records cannot capture, whether globally rated or behaviorally coded.

The term "contingency" is central in both paradigms, but defined very differently, an important source of confusion. Perhaps because Ainsworth was criticized for the value-laden implications of the term sensitivity, Blehar et al. (1977) used contingent responsivity as a synonym. In Ainsworth's approach, the global maternal measure of contingent responsivity (sensitivity) incorporated aspects of the infant's response to determine whether the mother is sensitive and was measured by ratings of the narrative transcripts of behavior.

In contrast, the definition of contingency and contingent responsiveness in the micro-analytic face-to-face interaction literature rests on statistical analyses of correlations between the moment-to-moment processes of the two partners' streams of behavior. This definition of contingency is neutral; its interpretation depends on its relation to other constructs, such as maternal depression or attachment security. This approach requires separate coding of each individual, across time, followed by computation of the degrees of correspondence between the two behavioral streams (Kenny, Kashy, & Cook, 2006; Moore et al., 2013). A central approach to the analysis of contingent coordination is that of time-series analysis, a sophisticated method built on correlation, which revolutionized the study of social interaction in the 1980s. Interactive contingency indexes degree of correspondence by assessing moment-to-moment adjustments that each individual makes to the partner's prior behavior. Metaphorically it measures expectancies of "how I affect you" and "how you affect me." Self-contingency indexes the degree to which an individual's behavior is predictable from her "just prior" behavior. It assesses degree of stability/lability within the individual's stream of behavior.

In calculating an individual's interactive contingency, her own self-contingency is statistically removed. Thus the analysis identifies whether, over and above the

predictability in the individual's behavior, there is any further variation in her behavior that is predicted by the prior behavior of the partner. Similarly, in calculating an individual's self-contingency, the individual's interactive contingency is removed (see Beebe et al., 2010 for details).

Contingency (coordination) as used in the microanalysis literature, and defined by time-series approaches, is a complex construct. Contingency as used here is not to be confused with maternal sensitivity or maternal contingent responsivity as used in the attachment literature.

The time-series measure of contingency rests on the infant's perceptual capacity. The infant is a remarkable "contingency detector" from birth (DeCasper & Carstens, 1980; Papousek, 1992). Infants detect predictable consequences of their actions, by estimating probabilities of "if-then" sequences (Saffran, Aslin, & Newport, 1996; Tarabulsy et al., 1996).

By 3–4 months, mothers and infants participate in an interactive "dance": contingently coordinating gaze patterns, yielding mutual gaze; facial affect, often termed facial mirroring; vocal rhythms, such as speech rate and turn-taking; orientation patterns, such as mutual approach or approach-avoid; and touch patterns (Beebe et al., 2010; Feldman, 2007; Jaffe et al., 2001; Malatesta, Culver, Tesman, & Shepard, 1989; Messinger, 2002; Stern, 1985; Tronick, 1989).

Self-regulation

From an attachment perspective, the regulation of affect is a central aspect of the attachment process as well as one of its most significant outcomes (Cassidy, 1994). The developmental trajectory proceeds from the establishment of internal working models (with significant caregivers) by the second half of the first year to the child's increasing ability to regulate affect. The infant's "lived" experiences are represented at various levels of specificity within the mind, serving as guides to perception of the self and others, including strategies for how to interpret and manage negative emotions. Although affect regulation is an aspect of functioning which resides in the child, it also reflects qualities of interactions with a specific caregiver. Infant management of negative affect in the Ainsworth Strange Situation reflects this process. For example, infants classified as avoidant tend to show minimal affect, while those classified as resistant maximize the affect they display, often showing distress without diminution in the caregiver's presence. Self- and interactive regulation patterns over the first year of life, however, have not been as systematically described in attachment research as they have in microanalytic research.

Within the face-to-face interaction literature, a sophisticated understanding of interactive regulation emerged with little attention to self-regulation (for an exception see Tronick, 1989). But the infant's experience is shaped not only by the parent's patterns of behavior, but also by his own. Increasingly, microanalysis researchers consider self-processes to be as important as interactive processes (Beebe et al., 2010, 2011; Chow, Haltigan, & Messinger, 2010; Feldman, Greenbaum, Yirmiya, & Mayes, 1996; Messinger, Ruvolo, Ekas, & Fogel, 2011). Fogel (1992) described all behavior as *unfolding in the individual*, while at the same time continuously modifying and being modified by the changing behavior of the partner.

One common definition of self-regulation is the down-regulation of negative affect. Another definition is based on the temporal patterning of social behaviors, and the degree to which current action is influenced by prior action, analyzed by time-series methods. This definition indexes the relative stability vs. variability of each person's own behaviors

over time and is fundamental to an understanding of social competence (Beebe et al., 2010, 2011; Messinger et al., 2011). We term this process "self-contingency" to distinguish it from more common definitions of self-regulation. It is so basic that it may seem invisible, like breathing. Because self-contingency provides the individual with continuous information about the likelihood of staying in the same state, it indexes the person's ability to anticipate, in the procedural mode, her own behavior from moment-to-moment.

Beebe et al. (2010) define each person's moment-to-moment adjustments to her own prior behavior as *self-contingency*, and to her partner's prior behavior as *interactive contingency*. These measures address self- and interactive contingency processes across the entire segment of the play session analyzed, rather than specific sequences of behaviors, such as maternal smile follows infant smile. For example, Beebe et al. (2010) measure maternal facial affect *interactive contingency* by how closely mothers coordinate (correlate) their entire range of facial affect changes, from positive to negative, with infant prior facial affect changes. That is, how closely does the mother follow or correspond to the infant's just previous direction of affective change, as the infant becomes more positive or negative? *Self-contingency* with respect to maternal facial affect measures how predictably degrees of positive to negative maternal facial affect unfold from moment-to-moment. For example, when mothers are overly stable in their facial affect from moment-to-moment, they may become "inscrutable" (see Beebe et al., 2010).

Infant procedural representation and the origins of attachment

The literature on internal working models of attachment, based on expectancies of actual experiences (Bowlby, 1969; Bretherton & Munholland, 1999; Main, Kaplan, & Cassidy, 1985), and a parallel literature on the origins of procedural, presymbolic forms of representations, also based on expectancies of actual experiences (for reviews see Beebe & Lachmann, 2002; Bornstein, 1985; Stern, 1985), have proceeded in parallel. An integration of these two literatures facilitates our ability to conceptualize the origins of attachment patterns.

As noted, infants are intrinsically motivated to detect pattern and order, to perceive contingency and degree of contingency, to anticipate when events will occur, to generate procedural expectancies, and to act on these expectancies (Haith, Hazan, & Goodman, 1988). Infants estimate probabilities of "if-then" sequences (Saffran et al., 1996), and engage in an active process of ordering and re-ordering information. This allows them to develop ongoing expectancies of sequences of events within the self, within the partner, and between the two. This procedural form of representation is based on the predictability of events and the perception of degree of contingent "control" over events (Stern, 1985; Tarabulsy et al., 1996). Infant procedural representational capacities in the first 3–4 months are already extensive (Bornstein, 1985; Haith et al., 1988; Shields & Rovee-Collier, 1992). Infants are highly sensitive to ways that their behaviors are contingently responded to (Beebe et al., 2010; DeCasper & Carstens, 1980; Haith et al., 1988; Jaffe et al., 2001; Muir & Hains, 1993; Murray & Trevarthen, 1985; Stern, 1985; Tarabulsy et al., 1996; Watson, 1985).

Procedural expectancies can be seen as the building blocks of infant internal working models of attachment as early as 4 months (Beebe et al., 2010; Stern, 1985). Microanalysis of 4-month face-to-face interactions may help us characterize in more detail what infants come to expect from interactions with their parents. Specifically, 4-month infant procedural expectancies of self- and interactive patterns provide ways of defining processes by which patterns of intimate relating and attachment security are constructed. Expectancies of

interactive contingency include the degree to which each person's changes correspond to the partner's direction of change; that is, how tightly mothers contingently coordinate with infants, how tightly infants contingently coordinate with mothers, and how stable/labile each partner's pattern of self-contingency may be. Expectancies of interactive contingency include the degree to which each person's changes correspond to the partner's direction of change. These are also expectancies of specific behavioral qualities, such as rates of looking away, or rates of intrusive touch. These patterns offer a more detailed perspective on the origins of infant working models of attachment as well as on forms of maternal sensitivity/insensitivity.

The optimal mid-range model

Contingency as used here is a neutral term. It acquires meaning only in relation to some other construct, such as attachment security. Mother–infant face-to-face interaction literature tends to assume that "more is better": more contingency, more coordination, more attunement, and more synchrony (see Tarabulsy et al., 1996; Van Egeren, Barratt, & Roach, 2001). But the role of degree of tightness/looseness of interpersonal coordination in infant development has been unclear (Jaffe et al., 2001; Keller, Lohaus, Volker, Cappenberg, & Chasiotis, 1999). High coordination (high interactive contingency) has been seen as more optimal for development (Chapple, 1970) or as an index of stress (Gottman, 1979).

A number of studies now converge on an "optimum midrange model" of interactive contingency for attachment and social outcomes, in which poles of higher and lower degrees of contingent coordination are both problematic. Maternal overstimulation, intrusiveness, inconsistency, and particularly high *or* low levels of maternal stimulation, maternal responsiveness, or infant responsiveness, predict insecure outcomes (Hane, Feldstein, & Dernetz, 2003; Isabella & Belsky, 1991; Jaffe et al., 2001; Lewis & Feiring, 1989; Leyendecker, Lamb, Fracasso, Scholmerich, & Larson, 1997; Malatesta et al., 1989).

The prediction of attachment from microanalytic studies

Relatively few studies have predicted 12-month attachment using detailed microanalytic coding of videotaped mother–infant interaction and contingency assessed with mathematical approaches. In this section a half dozen of such studies are briefly described, selected with the criteria of split-screen videotaping of mother–infant face-to-face play, the coding of behavior on a 1 s time base, and infant age 4 months (except where noted). Attachment may be assessed through classifications or through interaction scales (contact-initiating, contact-maintaining, resistance, avoidance). In such studies, the ways in which mother and infant jointly regulate communication at 4 months generates a trajectory in development that has been shown to predict attachment at 12 months. Communication modalities such as vocalization, attention, affect, head orientation, and touch are examined. Thus aspects of attachment patterns are already in place at 4 months, in subtle processes of face-to-face communication.

Langhorst and Fogel (1982) found that maternal stimulation (such as facial, vocal, or touch) during periods of infant gazing at mother, and holding back on stimulation during infant gaze aversion, was negatively correlated with avoidance in the Strange Situation. Maternal tendency to increase stimulation following negative infant cues was positively correlated with infant avoidance. Infant gaze aversion and postural "avoid" were also

positively correlated with avoidance. Stimulating while infants gaze (and holding back while infants look away) identifies one aspect of maternal *sensitivity*; conversely, maternal tendency to increase stimulation following infant distress identifies an aspect of maternal *insensitivity*. These findings are consistent with Brazelton, Kozlowski, and Main (1974), who proposed that mothers who reserve their stimulation for periods of infant gazing facilitate the infant's ability to use gaze aversion as a coping mechanism to down-regulate arousal as needed. These findings are consistent with Field's (1981) documentation that infants use periods of looking away from mother to down-regulate arousal and return to a comfortable baseline arousal level.

At 2.5, 5, and 7.5 months, Malatesta et al. (1989) analyzed maternal facial responsivity to infant facial affect, defined as maternal changes contingent within 1 s on infant changes (but did not analyze infant contingent on mother). Mothers of future secure infants showed moderate contingency, whereas those of future avoidant infants showed high levels of contingency. That is, mothers of secure infants followed the infant's direction of affective change to a moderate degree, whereas mothers of future avoidant infants followed more tightly. This finding is an early example of the optimal midrange model: the highest coordination is not necessarily optimal for secure attachment. A moderate level of maternal contingent facial coordination emerges as a dimension of maternal sensitivity.

Slade et al. (1995) used contingency measurements of mother and infant social engagement with findings similar to those of Malatesta et al. (1989), and Tobias (1995) used the Adult Attachment Interview (AAI) administered in the last trimester of the mother's pregnancy to predict mother–infant interaction. Mothers who were Free-Autonomous/secure on the AAI showed moderate degrees of contingency when interacting with their infants at 4 months, whereas mothers classified as Preoccupied/Entangled showed higher degrees of contingency. Strikingly, the infants' level of contingency matched that of their mothers. Again, a moderate level of maternal contingent coordination emerged as an aspect of maternal sensitivity. This study also shows that the mother's state of mind with respect to attachment, visible in pregnancy, predicts maternal communication at 4 months, providing one of the first links between maternal states of mind and face-to-face communication.

The still-face paradigm (Tronick, 1989) introduces a brief interruption into mother–infant face-to-face play. Following regular play, the mother is instructed to hold a completely still face for 2 minutes. Thereafter the play resumes normally. Tronick (1989) found that infants who experienced more repairs of mismatches in an ongoing interaction, and who used more adaptive methods of coping with the still-face experiment (such as continuing to signal the mother), were more likely to have secure attachments. Using the still-face paradigm, Cohn, Campbell, and Ross (1991) showed that 6-month future secure, but not avoidant, infants displayed positive signaling/eliciting behaviors while mother maintained a still face. Infants who continue to signal their mothers, in a positive fashion, are more likely to become securely attached.

Braungart-Rieker, Garwood, Powers, and Wang (2001) analyzed 4-month infant facial/vocal affect and self-regulation (self-touch/focus on something other than mother) during the still-face episode, and maternal sensitivity (coded on 5-point scale every 10 s epoch) during free-play. Greater 4-month maternal sensitivity predicted 12-month security. Future avoidant infants showed higher levels of 4-month self-regulation; future secure infants showed midrange levels; and future resistant infants showed low levels, again pointing to an optimal mid-range model.

Jaffe et al. (2001) predicted 12-month disorganized, resistant, and avoidant attachment, compared to secure, from degree of 4-month vocal rhythm coordination, coded on a ¼ s time base. Vocal rhythm coordination assesses the degree each individual "matches" (correlates) the *durations* of vocal sounds and silences with that of the partner. Particularly salient was the vocal turn-taking coordination, as each partner may match the duration of the "switching" pause as partners switch vocal turns. Time-series methods were used to determine degree of contingent coordination. Again, a midrange degree of interactive contingency (coordination) predicted security: a moderate degree of correspondence with the partner's rhythms of turn taking. Higher and lower degrees predicted disorganized/resistant and avoidant attachment, respectively. Higher coordination increases the predictability of the interaction and was here interpreted as excessive monitoring, "trying too hard," or "vigilance," a coping strategy elicited by novelty, interactive challenge, or threat. Lower coordination was interpreted as inhibition of monitoring, or withdrawal. Midrange coordination may leave more "space," more room for uncertainty, initiative, and flexibility within the experience of correspondence and contingency, optimal for secure attachment. Thus one aspect of maternal sensitivity from an attachment perspective may be moderate levels of maternal contingent coordination.

Working with the Jaffe et al. (2001) data set, Koulomzin et al. (2002) predicted 12-month secure vs. avoidant attachment from infant behavior during face-to-face interaction. Unusual in microanalysis studies, mother behavior was not coded. What is particularly interesting in this study is that attachment was predicted by the infant's behavior alone. Future secure (vs. avoidant) infants looked at mother more, with a more stable pattern; and showed greater range of positive and negative facial signaling, more sustained gaze, and more coordinated gaze/head orientation (yielding a stable focus of attention to mother's face), regardless of self-touch/mouthing. Future avoidant infants showed more frequent and variable tactile behaviors, more looking away, and looking at mother with a wandering head. Future avoidant infants maintained a level of stable gaze at mother equal to that of future secure infants only if involved in self-touch/mouthing.

From these studies, the following aspects of maternal sensitivity emerge in relation to infant attachment outcomes: (1) stimulating while infants gaze at mother, and holding back on stimulating while infants gaze avert, facilitates infant ability to use looking away as a coping mechanism to down-regulate arousal; (2) maternal tendency to increase stimulation following infant distress is an aspect of maternal insensitivity; (3) contingent maternal coordination with infant behavior that is "midrange" in degree, neither very high or very low, predicts attachment security; and (4) maternal facilitation of repair following disruptions predicts attachment security.

Beebe et al. (2010): the origins of disorganized attachment at 4 months

We turn to a study by Beebe et al. (2010) that predicted 12-month attachment outcomes from 2.5 minutes of mother–infant face-to-face communication at 4 months. We summarize here the prediction of 12-month disorganized attachment from 4-month behavior, contrasting secure (B), $N = 47$, vs. disorganized (D), $N = 17$. Attachment classifications were coded by Elizabeth Carlson. For details of method, statistical analyses, and results, see Beebe et al. (2010).

The mother was instructed to play with her 4-month infant as she would at home, but without toys, for 10 minutes. The first 2.5 uninterrupted continuous minutes of videotaped interaction were coded on a 1 s time base by coders blind to attachment status. Analysis of only a few minutes of video footage is consistent with the microanalysis literature

(Ambady & Rosenthal, 1992; Cohn & Tronick, 1989; Messinger, 2002) and yields robust session-to-session consistency (Cohn & Tronick, 1989; Weinberg & Tronick, 1991; Zelner, Beebe, & Jaffe, 1982).

In this study, unlike many other microanalytic studies cited above, many communication modalities were examined simultaneously (rather than one modality, such as vocalization or gaze). Attention, emotion, orientation, and touch were coded. Moreover, both self-regulation and interactive regulation were assessed.

Mothers and infants were coded independently as follows. For mothers: gaze, facial affect, touch, and spatial orientation; for infants: gaze, facial affect, vocal affect, touch, and head orientation. Two types of measures were generated: *frequencies of behavioral qualities*, such as gaze aversion or intrusive touch; and the *process of relating across time*, measured by self- and interactive contingency.

Interactive contingency is defined as adjustments of one individual's behavior that are correlated with the partner's prior behavior. *Self-contingency* is defined as adjustments of an individual's behavior that are correlated with his or her own prior behavior (in the context of a particular partner). Self-contingency refers to the degree of predictability (stability/lability) within an individual's own rhythms of activity; it provides the individual with continuous information about the likelihood of staying in the same state.

Beebe et al. (2010) asked whether 4-month infants and mothers who were classified as disorganized at 12 months ("future" disorganized at 4 months) differed from those classified as secure ("future" secure). Regarding contingency measures, they asked which partner (mother or infant) in future disorganized dyads might show 4-month degree of contingency that differs from that of future secure dyads; whether contingency is increased, or decreased, relative to secure dyads; the type of contingency that is altered, self- or interactive; and the communication modality in which contingency is altered.

Antecedents of disorganized (vs. secure) attachment were found: both in frequencies of behavioral qualities and in contingencies; in both mothers and infants; in self-contingency as well as interactive contingency; in both increased and decreased contingencies relative to secure dyads; and in all communication modalities assessed (attention, emotion, orientation, and touch).

Mothers of future disorganized infants bring their own difficult attachment history to their interactions with their infants. They are likely to suffer from unresolved loss, abuse, or trauma (Lyons-Ruth et al., 1999; Main & Hesse, 1990; Main et al., 1985). Difficulties with their own distress are likely to disturb their responses to distress in their infants.

Despite important recent progress in understanding disorganized attachment, we still lack a full understanding of how disorganized attachment is formed prior to 12 months (Leyendecker et al., 1997; Madigan et al., 2006; Main & Hesse, 1990; Main & Solomon, 1990). Maternal behavior within the Ainsworth Strange Situation has been found to be frightened and/or frightening (Jacobvitz, Hazen, & Riggs, 1997; Lyons-Ruth et al., 1999; Schuengel, Bakermans-Kranenburg, & Van IJzendoorn, 1999). Lyons-Ruth et al. (1999) suggested that the degree of communicative derailment seen in disorganized dyads "should be fear-arousing in itself because the infant will have little sense of influence over the caregiver at times of heightened fear or stress" (p. 69).

In our analyses, infants' diminished sense of influence is translated into lowered maternal contingent coordination with infant behavior: the mother does not predictably follow the direction of the infant's prior behavior (such as becoming more positive as the infant does so, and dampening to concern as the infant becomes distressed). When the infant has difficulty predicting what the mother will do next, his expectation that he can influence her is lowered, impairing a sense of agency. We also hypothesized that future

disorganized (vs. secure) infants use more discrepant affect (simultaneous positive and negative facial and/or vocal affect), based on the frequently observed simultaneous approach and avoidance behavior shown by infants classified as disorganized in the Strange Situation.

Summary of future disorganized (vs. secure) dyads at 4 months

Four-month infants who will be classified disorganized (vs. secure) at 12 months were more likely to be male and to show complex forms of dysregulation:

- more vocal distress, and more combined facial and/or vocal distress;
- more *discrepant* facial and vocal affect in the same second;
- lowered engagement self-contingency, an emotional destabilization;
- more failure to touch, less touching one's own skin, and greater likelihood of continuing in a "no touch" state, all of which compromise infant access to arousal regulation through touch, in the context of increased distress.

Mothers of 4-month infants who will be classified disorganized (vs. secure) at 12 months were more likely to show the following patterns:

- extensive (20% of the time or more) gazing away from infant's face (14.9% of mothers of future B and 35% of mothers of future D infants met this criterion), and less predictable self-contingency patterns of gazing at and away from the infant, compromising infant ability to expect and rely on predictable maternal visual attention;
- extensive (20% of the time or more) "looming" head movements, which were relatively unpredictable, interpreted as potentially threatening;
- greater likelihood of positive and/or surprise expressions while infants were distressed, interpreted as maternal emotional "denial" of infant distress;
- lowered emotional (facial-visual engagement) coordination with infant emotional ups and downs, interpreted as maternal emotional withdrawal from distressed infants;
- heightened maternal facial self-contingency, an overly stable face leading to a "closed-up" inscrutable face;
- lowered maternal contingent touch coordination with infant touch, a form of withdrawal.

Infant distress and discrepant affect

Compared to future secure infants, future disorganized infants at 4 months show more vocal distress, and combined facial and/or vocal distress. They also show more discrepant affect within the same second, such as smile with whimper. These are painful moments to watch. Because of discrepant affect, it may be difficult for future disorganized infants eventually to recognize what they feel, or know how to make sense of their contradictory feelings. Contradictory positive and negative infant affect at 4 months is strikingly similar to contradictory infant approach and withdrawal behavior at 12 months in the Strange Situation, a key feature of disorganized attachment.

Dyadic affective conflict: maternal smile or surprise to infant distress

Not only the infant but also the dyad was in affective conflict. Mothers of future disorganized (vs. secure) infants were more likely to show smile and/or surprise faces specifically following infant facial/vocal distress: a maternal emotional "denial" of infant distress. Thus these mothers "opposed" or "countered" infant distress, literally going in the opposite affective direction, as if attempting to "ride negative into positive." The infant's expectation of matching and being matched in the direction of affective change, which lays the groundwork for feeling "attuned to" or "on the same wavelength," is disturbed. We propose that unresolved fears about intimate relating in these mothers trigger complex "defensive" maneuvers and contradictory behavioral tendencies that derail their infants. Smiling and surprise faces in response to infant distress can be seen as a disturbance in maternal sensitivity. We infer that these infants come to *expect* that their mothers do not empathically share their distress.

Dyadic conflict: attention dysregulation

Despite greater distress in future disorganized infants, as noted above, their mothers showed extensive gazing away from the infant's face. Moreover, these mothers showed less self-predictability in patterns of gazing at and away from the infant's face. This pattern may lead to infant feelings of being too visually "separate" from their mothers, of not being "seen," and of being confused about mother's visual presence and availability. Thus infant ability to rely on a predictable maternal pattern of visual attention is compromised.

Extensive maternal looking away may reflect maternal discomfort with intimate engagement through mutual gaze, or it may reflect moments of maternal dissociation. Maternal dissociation fits the literature on the adult attachment interview in which forms of dissociation such as lapses in attention, dysfluencies, or entertaining contradictory facts are characteristic of mothers classified as "unresolved," who are likely to have disorganized infants (Main, Hesse, & Goldwyn, 2008). Extensive maternal looking away can also be seen as a disturbance in maternal sensitivity.

Maternal intermodal discordance

Mothers of future disorganized infants exhibited an intermodal discordance between extensive gazing away, thus "too far away," and extensive looming into the infant's face, thus "too close in." Both gazing away and looming in disturb the potential for mutual gaze. Because eye contact is arousing, we conjecture that both these maternal behaviors reflect her concerns about visual intimacy, which may be over-arousing.

Both maternal gaze away and maternal loom occurred in the context of lowered maternal visual and spatial self-predictability. Not only is there a maternal intermodal discordance (looming in/gazing away), but these discordant behaviors unfold in relatively unpredictable ways. This constellation defines a disturbance in maternal sensitivity.

Dyadic conflict: lowered maternal engagement coordination

A third form of dyadic conflict was seen when, despite infant distress, mothers of future disorganized infants lowered their facial-visual engagement coordination with infant engagement: an emotional-attentional withdrawal from contingently coordinating with

infant positive as well as distress moments. These mothers did not join the infant's attentional and emotional direction, disturbing the likelihood of shared affective processes, consistent with our hypothesis. Although the prevalence of *behavioral qualities* of positive or negative facial affect did not differ in mothers of future disorganized vs. secure infants, the ways that mothers *contingently coordinated* their facial-visual behavior with that of the infants differed. Thus the disturbance is found in the *process* of relating over time, rather than the mere frequency of behaviors, defining another dimension of disturbance in maternal sensitivity.

Maternal withdrawal makes it difficult for future disorganized infants to come to expect that their behaviors can influence mothers to coordinate with them, to join their distressed or their positive states. In short, infants are relatively helpless to affect mothers with their facial-visual engagement processes, which disturbs the infant's sense of interactive efficacy.

Lowered maternal facial coordination with infant facial or vocal affect, or lowered maternal gaze coordination with infant gaze, was not found in mothers of future disorganized infants when these communication modalities were analyzed separately. Thus mothers of future disorganized infants *perceive* infant affect and gaze and in many ways are adequately responsive. Instead, it is only when the overall *gestalt* of infant facial-visual *engagement* (which includes infant head orientation and vocal affect as well) is considered that we find lowered maternal coordination. Thus, although facial-mirroring seems intact, maternal mirroring of the entire infant facial-vocal-visual-head-orientation gestalt is not.

We theorize that mothers of future disorganized infants cannot coordinate with infant emotional ups and downs, and cannot acknowledge moments of infant distress, because they cannot bear to pay attention to their own emotional distress. The infant's distress may evoke the mother's own distress, and her ensuing efforts to manage it. We interpret the mother's lowered emotional responsivity (lowered contingent engagement coordination with infant engagement), as well as maternal smile or surprise to infant distress, as maternal emotional "denial" of infant distress. Although minimization of distress has been associated with avoidant attachment (Cassidy, 1994), the forms of maternal denial of distress documented here are different from minimization. Lowered emotional coordination communicates to the infant: "You can't affect me." Showing the opposite (positive) emotion to the infant's negative emotion constitutes an "opposing" of the infant's emotion, communicating: "I'm not going there." We propose that the infant represents these maternal responses to his distress through procedurally organized expectancies of action sequences. Moreover, one aspect of this representation is the infant's own distress and potential alarm.

Heightened maternal facial self-contingency: "closing up one's face"

Lowered maternal engagement coordination was accompanied by mothers remaining overly facially stable or too "steady-state," like a momentary "still-face" (Tronick, 1989). We interpret this finding as mothers "closing up their faces"; another way of not being available to the "play of faces" and another way of saying "you can't affect me." To remain empathic to infant distress might re-evoke aspects of the mother's own original traumatized state. This facial over-stabilization provides another dimension of disturbance in maternal sensitivity. Ainsworth also described mothers of some avoidant infants as inexpressive/"poker-faced" (Inge Bretherton, personal communication, 8 June 2013).

The constellation of momentarily closing her face, lowering her ongoing coordination with the infant's emotional shifts, and extensive looking away from her infant's face, may be ways of shutting herself down in a self-protective effort, possibly dissociative. This pattern disturbs the infant's ability to feel sensed. We infer that future disorganized infants come to expect that their mothers do not "join" their distress with acknowledgments such as maternal "woe face," an empathic form of maternal facial mirroring. Instead they come to expect that their mothers are happy, surprised, or "closed" when they are distressed.

Lowered infant engagement self-predictability: Infant "destabilization"

In the context of lowered maternal engagement coordination, future disorganized (vs. secure) infants lowered their facial-visual engagement self-predictability. That is, from moment-to-moment the future disorganized (vs. secure) infant's level of facial-visual engagement is less predictable from the immediately prior state. This finding indicates a more variable process in which the infant's ability to anticipate his own moment-to-moment action tendencies is lowered. Infants are metaphorically "destabilized."

Dyadic touch dysregulation

Mothers of future disorganized (vs. secure) infants not only lowered their contingent engagement coordination with infant engagement, disturbing infant interactive efficacy in the facial-visual realm, but they also lowered contingent touch coordination with infant touch, disturbing infant interactive efficacy in the touch realm. These mothers were less able than mothers of secure infants to acknowledge increasing frequency of infant touch as a cue for more affectionate, tender touch. This pattern provides another dimension of disturbance in maternal sensitivity. We infer that future disorganized infants come to expect that their mothers will be unavailable to help modulate states of affective distress through maternal touch coordination with their own touch behavior: an interpersonal touch dysregulation. Infants are left too alone, too separate, in the realm of touch.

Simultaneously, future disorganized infants showed an intrapersonal touch dysregulation: less touch overall, specifically less touching of their own skin, and greater likelihood of continuing in states of "no touch," metaphorically "getting stuck in states of no-touch." Lowered infant access to his own touch further disturbs infant regulation of distress through touch (self-soothing, fingering an object or his mother). Together, future disorganized infants and their mothers thus showed a dyadic touch dysregulation.

If their procedural experience could be put into words, we imagine future disorganized infants might experience: "I'm so upset and you're not helping me. I'm smiling at you and whimpering; don't you see I want you to love me? When I'm upset, you smile or close up or look away. You make me feel worse. I feel confused about what I feel and about what you feel. I can't predict you. I don't know what is going on. What am I supposed to do? I feel helpless to affect you. I feel helpless to help myself. I feel frantic. I feel unsafe."

In an effort to understand further mothers of future disorganized infants, we note that a facial expression produced by one person tends to evoke a similar expression in the partner, out of awareness (Dimberg, Thunberg, & Elmehed, 2000), a powerful way of participating in the state of the other. This is such a robust phenomenon that some researchers dub it an "automatic" facial mimicry (Hatfield, Cacioppo, & Rapson, 1993). But as we have seen, mothers of future disorganized infants do not match or empathically join the facial distress of their infants. We conjecture that mothers of future disorganized infants cannot process and respond to emotional information in the moment because they

are flooded by their experience of the infant's distress, which may re-evoke earlier traumatic states of their own. They may shut down their own emotional processing, and be unable to use the infant's distress behaviors as communications, in a momentary dissociative process.

Emerging internal working models of future disorganized infants at 4 months

The proposal of this research is that future disorganized infants represent these individual and dyadic patterns as emerging internal working models of self-with-mother in the form of procedural representations, based on expectancies of self- and interactive patterns. These expectancies bias the trajectory of how experience is organized, activating certain pathways and inhibiting others, ultimately limiting the range, flexibility, and *coherence* of experience. The findings show many forms of intrapersonal and interpersonal conflict, intermodal discordance, or contradiction, leading to confusion and incoherent working models in future disorganized infants. Our results provide one response to the Madigan et al. (2006) call for better identification of the details of the elusive behaviors of anomalous parenting directly implicated in the development of disorganized attachment.

Emerging internal working models of future disorganized infants with their mothers are characterized by expectancies of intense infant emotional distress and inability to obtain comfort. In many ways, future disorganized infants are alone with their facial/vocal distress and helpless to affect their mothers with their frantic distress. At critical moments they are opposed by their mothers. A second feature is an expectancy of difficulty predicting what will happen, both within the self and within the partner. A third feature is difficulty in knowing what the self feels and what the partner feels: a form of emotional incoherence. A fourth feature is a disturbance in experiences of recognition, leading to the expectation of not feeling "sensed" or "known," particularly when distressed. These profound experiences of non-recognition may disturb the infant's core sense of safety. A further critical feature of these expectancies of future disorganized infants is the experience of intrapersonal and dyadic contradictory communications, conflict, and remarkable intermodal discrepancies. These contradictions disturb the coherence of the infant's emerging internal working model.

In sum, many fundamental disturbances in the processes through which future disorganized infants may come to feel known and can recognize being recognized, through which infants may come to know their mothers, and through which infants come to sense their own states, can be elucidated with a microanalytic approach. This picture provides detailed behavioral mechanisms that could result in the lack of a consistent strategy of dealing with negative emotions, characteristic of disorganized infants in the Strange Situation by 12 months (Van IJzendoorn, Schuengel, & Bakerman-Kranenburg, 1999). The disturbance in individual and dyadic emotional coherence in future disorganized infants and their mothers offers a striking parallel to the contradictory and unintegrated affects of disorganized infants in the Ainsworth Strange Situation, and to the contradictory evaluations of attachment relationships in the findings of their mothers in the Adult Attachment Interview.

Conclusion

The microanalysis approach opens up a new window on the micro-processes of face-to-face communication and attachment formation, revealing aspects of the origins of

attachment with a more detailed lens. By coding rapid communications which are often not quite perceptible in real time, it provides a remarkable "social microscope."

The purpose of this paper is not to suggest microanalysis as a method for mainstream attachment research. Instead, we illustrated the kinds of detailed information regarding the origins of disorganized attachment that the microanalysis approach can generate. This approach provides a new, rich set of behaviors and self- and interactive patterns that extend our understanding of the origins of infant disorganized attachment, and of patterns of maternal sensitivity and insensitivity.

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References

Ainsworth, M., Bell, S., & Stayton, D. (1974). Individual differences in the development of some attachment behaviors. *Merrill-Palmer Quarterly of Behavior and Development*, *18*(2), 123–143.

Ainsworth, M., Blehar, M., Waters, E., & Wall, S. (1978). *Patterns of attachment: A psychological study of the strange situation*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Ambady, N., & Rosenthal, R. (1992). Thin slices of expressive behavior as predictors of interpersonal consequences: A meta-analysis. *Psychological Bulletin*, *2*, 256–274.

Beebe, B., Jaffe, J., Markese, S., Buck, K., Chen, H., Cohen, P., … Feldstein, S. (2010). The origins of 12-month attachment: A microanalysis of 4-month mother-infant interaction. *Attachment & Human Development*, *12*(1–2), 1–135.

Beebe, B., & Lachmann, F. (2002). *Infant research and adult treatment: Co-constructing interactions*. Hillsdale, NJ: The Analytic Press.

Beebe, B., & Lachmann, F. (2013). *The origins of attachment: Infant research and adult treatment*. London: Routledge.

Beebe, B., Steele, M., Jaffe, J., Buck, K., Chen, H., Cohen, P., … Feldstein, S. (2011). Maternal anxiety and 4-month mother-infant self- and interactive contingency. *Infant Mental Health Journal*, *32*(2), 174–206.

Blehar, M., Lieberman, A., & Ainsworth, M. (1977). Early face-to-face interaction and its relation to later infant-mother attachment. *Child Development*, *48*, 182–194.

Bornstein, M. (1985). Infant into adult: Unity to diversity in the development of visual categorization. In J. Mehler & R. Fox (Eds.), *Neonate cognition* (pp. 115–138). Hillsdale, NJ: Lawrence Erlbaum Associates.

Bowlby, J. (1969). *Attachment and loss*. New York, NY: Basic Books.

Braungart-Rieker, J., Garwood, M., Powers, B., & Wang, X. (2001). Parental sensitivity, infant affect, and affect regulation: Predictors of later attachment. *Child Development*, *72*(1), 252–270.

Brazelton, T., Kozlowski, B., & Main, M. (1974). The origins of reciprocity. In M. Lewis & L. Rosenblum (Eds.), *The effects of the infant on its caregiver* (pp. 137–154). New York, NY: Wiley-Interscience.

Bretherton, I., & Munholland, K. (1999). Internal working models in attachment: A construct revisited. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment theory* (pp. 89–111). New York, NY: Guilford Press.

Cassidy, J. (1994). Emotion regulation: Influences of attachment relationships. *Monographs of the Society for Research in Child Development*, *59*(2–3 Serial No. 240), 2228–2249.

Chapple, E. (1970). *Culture and biological man*. New York, NY: Hold, Rinehart & Winston.

Chow, S., Haltigan, J., & Messinger, D. (2010). Dynamic infant–parent affect coupling during the face-to-face/still-face. *Emotion*, *10*(1), 101–114.

Cohn, J., Campbell, S., & Ross, S. (1991). Infant response in the still-face paradigm at 6 months predicts avoidant and secure attachments at 12 months. *Development and Psychopathology*, *3*, 367–376.
Cohn, J., & Tronick, E. (1989). Mother-infant face-to-face interaction: The sequence of dyadic states at 3, 6, 9 months. *Developmental Psychology*, *23*, 68–77.
De Wolff, M., & Van Ijzendoorn, M. (1997). Sensitivity and attachment: A meta-analysis on parental antecedents of infant attachment. *Child Development*, *68*, 571–591.
DeCasper, A., & Carstens, A. (1980). Contingencies of stimulation: Effects on learning and emotion in neonates. *Infant Behavior and Development*, *9*, 19–36.
Dimberg, U., Thunberg, M., & Elmehed, K. (2000). Unconscious facial reactions to emotional facial expressions. *Psychological Science*, *11*(1), 86–89.
Feldman, R. (2007). Parent-infant synchrony and the construction of shared timing; physiological precursors, developmental outcomes and risk conditions. *Journal of Child Psychology and Psychiatry*, *48*(3–4), 329–354.
Feldman, R., Greenbaum, C., Yirmiya, N., & Mayes, L. (1996). Relations between cyclicity and regulation in mother-infant interaction at 3 and 9 months and cognition at 2 years. *Journal of Applied Developmental Psychology*, *17*, 347–365.
Field, T. (1981). Infant gaze aversion and heart rate during face-to-face interactions. *Infant Behavior and Development*, *4*, 307–315.
Fogel, A. (1992). Co-regulation, perception and action. *Human Movement Science*, *11*, 505–523.
Gottman, J. (1979). *Marital interactions*. New York, NY: Academic Press.
Haith, M., Hazan, C., & Goodman, G. (1988). Expectation and anticipation of dynamic visual events by 3.5 month old babies. *Child Development*, *59*, 467–479.
Hane, A., Feldstein, S., & Dernetz, V. (2003). The relation between coordinated interpersonal timing and maternal sensitivity in four-month-old infants. *Journal of Psycholinguistic Research*, *32*, 525–539.
Hatfield, E., Cacioppo, J., & Rapson, R. (1993). Emotional contagion. *Current Directions in Psychological Science*, *2*, 96–99.
Hofer, M. (1994). Hidden regulators in attachment, separation and loss. *Monographs of the Society for Research in Child Development*, *59*(2–3, Serial No. 240), 192–207.
Isabella, R., & Belsky, J. (1991). Interactional synchrony and the origins of infant-mother attachment: A replication study. *Child Development*, *62*, 373–384.
Jacobvitz, D., Hazen, N., & Riggs, S. (1997, April). *Disorganized mental processes in mothers: Frightening/frightened caregiving and disoriented*, *disorganized behavior in infancy*. Paper presented at the biennial meeting of the Society for Research in Child Development, Washington, DC.
Jaffe, J., Beebe, B., Feldstein, S., Crown, C., & Jasnow, M. (2001). Rhythms of dialogue in infancy. *Monographs of the Society for Research in Child Development*, *66*(2, Serial No. 264), 1–132.
Keller, H., Lohaus, A., Volker, S., Cappenberg, M., & Chasiotis, A. (1999). Temporal contingency as an independent component of parenting behavior. *Child Development*, *70*, 474–485.
Kenny, D., Kashy, D., & Cook, W. (2006). *Dyadic Data Analysis*. New York, NY: Guilford Press.
Koulomzin, M., Beebe, B., Anderson, S., Jaffe, J., Feldstein, S., & Crown, C. (2002). Infant gaze, head, face, and self-touch at four months differentiate secure vs. avoidant attachment at one year: A microanalytic approach. *Attachment & Human Development*, *4*, 3–24.
Langhorst, B., & Fogel, A. (1982, March). *Cross validation of microanalytic approaches to face-to-face play*. Presented at International conference on Infant Studies, Austin, TX.
Lewis, M., & Feiring, C. (1989). Infant, mother and mother-infant interaction behavior and subsequent attachment. *Child Development*, *60*, 831–837.
Leyendecker, B., Lamb, M., Fracasso, M., Scholmerich, A., & Larson, D. (1997). Playful interaction and the antecedents of attachment: A longitudinal study of Central American and Euro-American mothers and infants. *Merrill Palmer Quarterly*, *43*, 24–47.
Lyons-Ruth, K., Bronfman, E., & Parsons, E. (1999). Maternal disrupted affective communication, maternal frightened or frightening behavior, and disorganized infant attachment strategies. *Monographs of the Society for Research in Child Development*, *64*(3 Serial No. 258), 67–96.
Madigan, S., Bakermans-Kranenburg, M., Van IJzendoorn, M., Moran, G., Pederson, D., & Benoit, D. (2006). Unresolved states of mind anomalous parental behavior, and disorganized attachment: A review and meta-analysis of a transmission gap. *Attachment & Human Development*, *8*, 89–111.

Main, M., & Hesse, E. (1990). Parents' unresolved traumatic experiences are related to infant disorganized attachment status: Is frightened and/or frightening parental behavior the linking mechanism? In M. Greenberg, D. Cicchetti, & E. Cummings (Eds.), *Attachment in the preschool years: Theory, research, and intervention* (pp. 161–182). Chicago, IL: University of Chicago Press.

Main, M., Hesse, E., & Goldwyn, R. (2008). Studying differences in language usage in recounting attachment history: An introduction to the AAI. In H. Steele & M. Steele (Eds.), *Clinical application of the adult attachment interview* (pp. 31–68). New York, NY: The Guilford Press.

Main, M., Kaplan, N., & Cassidy, J. (1985). Security in infancy, childhood, and adulthood: A move to the level of representation. *Monographs of the Society for Research in Child Development*, *50* (Serial No. 209), 66–104.

Main, M., & Solomon, J. (1990). Procedures for identifying infants as disorganized/disoriented during the Ainsworth Strange Situation. In M. Greenberg, D. Cicchetti & E. Cummings (Eds.), *Attachment in the preschool years* (pp. 121–160). Chicago, IL: University of Chicago Press.

Malatesta, C., Culver, C., Tesman, J., & Shepard, B. (1989). The development of emotion expression during the first two years of life. *Monographs of the Society for Research in Child Development*, *54*(Serial No. 219, Nos. 1–2), 1–136.

Messinger, D. (2002). Positive and negative: Infant facial expressions and emotions. *Current Directions in Psychological Science*, *11*, 1–6.

Messinger, D., Ruvolo, P., Ekas, N., & Fogel, A. (2011). "Are you interested, baby?" Young infants exhibit stable patterns of attention during interaction. *Infancy*, *17*(2), 233–244.

Moore, G., Powers, C., Bass, A., Cohn, J., Propper, C., Allen, N., & Lewinsohn, P. (2013). Dyadic interaction: Greater than the sum of its parts? *Infancy*, *18*(4), 490–515.

Muir, D., & Hains, S. (1993). Infantile sensitivity to perturbations in adult facial, vocal, tactile, and contingent stimulation during face-to-face interaction. In B. DeBoysson-Bardies, S. DeSchonen, P. Jusczyk, P. McNeilage, & J. Morton (Eds.), *Developmental neurocognition: Speech and face processing in the first year of life* (pp. 171–185). Dordrecht: Kluwer Academic Publications.

Murray, L., & Trevarthen, C. (1985). Emotional regulation of interactions between two-month-olds and their mothers. In T. Field & N. Fox (Eds.), *Social perception in infants* (pp. 177–197). Norwood, NJ: Ablex.

Papousek, M. (1992). Early ontogeny of vocal communication in parent-infant interaction. In H. Papousek, U. Juergens, & M. Papousek (Eds.), *Nonverbal vocal communication* (p. 230) New York, NY: Cambridge University Press.

Saffran, J., Aslin, R., & Newport, E. (1996). Statistical learning by 8-month-old infants. *Science*, *274*, 1926–1928.

Sander, L. (1977). The regulation of exchange in the infant-caretaker system and some aspects of the context-content relationship. In M. Lewis & L. Rosenblum (Eds.), *Interaction, conversation, and the development of language* (pp. 133–156). New York, NY: Wiley.

Schuengel, C., Bakermans-Kranenburg, M., & Van IJzendoorn, M. (1999). Frightening maternal behavior linking unresolved loss and disorganized infant attachment. *Journal of Consulting and Clinical Psychology*, *67*, 54–63.

Shields, P., & Rovee-Collier, C. (1992). Long-term memory for context-specific category information at six months. *Child Development*, *63*, 245–259.

Slade, A., Dermer, M., Gerber, J., Gibson, L., Graf, F., Siegel, N., & Tobias, K. (1995, March). *Prenatal representation, dyadic interaction and quality of attachment*. Paper presented at the meeting of the Society for Research in Child Development, Indianapolis, IN.

Stern, D. (1971). A microanalysis of the mother-infant interaction. *Journal of the American Academy of Child Psychiatry*, *10*, 501–507.

Stern, D. (1974). Mother and infant at play: The dyadic interaction involving facial, vocal and gaze behaviors. In M. Lewis & L. Rosenblum (Eds.), *The effect of the infant on its caregiver* (pp. 187–213). New York, NY: Wiley.

Stern, D. (1985). *The interpersonal world of the infant*. New York, NY: Basic Books.

Stern, D., Sander, L., Nahum, J., Harrison, A., Bruschweiler-Stern, N., & Tronick, E. (1998). Non-interpretative mechanisms in psychoanalytic therapy. *International Journal of Psycho-Analysis*, *79*, 903–921.

Tarabulsy, G., Tessier, R., & Kappas, A. (1996). Contingency detection and the contingent organization of behavior interactions: Implications for socioemotional development in infancy. *Psychological Bulletin*, *120*, 25–41.

Tobias, K. (1995). *The relation between maternal attachment and patterns of mother-infant interaction at four months* (Unpublished doctoral dissertation). City University of New York, New York, NY.

Trevarthen, C. (1974). The psychobiology of speech development. In E. Lenneberg (Ed.), *Language and brain: Developmental aspects. Neurosciences Research Program Bulletin, 12*, 570–585.

Tronick, E. (1989). Emotions and emotional communication in infants. *American Psychologist*, *44*, 112–119.

Van Egeren, L., Barratt, M., & Roach, M. (2001). Mother-infant responsiveness: Timing, mutual regulation, and interactional context. *Developmental Psychology*, *37*(5), 684–697.

Van IJzendoorn, M., Schuengel, C., & Bakerman-Kranenburg, M. (1999). Disorganized attachment in early childhood: Meta-analysis of precursors, concomitants and sequelae. *Development and Psychopathology*, *11*, 225–250.

Watson, J. (1985). Contingency perception in early social development. In T. Field & N. Fox (Eds.), *Social perception in infants* (pp. 157–176). Norwood, NJ: Ablex.

Weinberg, K., & Tronick, E. (1991). *Stability of infant social and coping behaviors and affective displays between 6 and 15 months: Age-appropriate tasks and stress bring out stability.* Paper presented at the Society for Research in Child Development, Seattle, Washington, DC.

Zelner, S., Beebe, B., & Jaffe, J. (1982, April). *The organization of vocalization and gaze in early mother-infant interactive regulation*. Presented at the International conference on Infant Studies, New York, NY.