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On the Origins of Disorganized Attachment and Internal Working Models: Paper I. A Dyadic Systems Approach

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Despite important recent progress in understanding disorganized attachment, we still lack a full understanding of the mechanisms of disorganized attachment formation and transmission prior to 12 months. In this paper we lay out our recommendations for the study of the 4-month origins of disorganized attachment. In our subsequent Paper II we report on the results of a large empirical study that was conducted along the lines we recommend in Paper I. Both Papers I and II are based on Beebe et al. (2010). In Paper I we describe our proposal that a detailed microanalysis of 4-month mother–infant face-to-face communication would further inform our understanding of the process of disorganized attachment formation between mother and infant. Such a microanalysis would allow us to characterize the nature of the 4-month infant’s procedural representations, or emerging “internal working models” of attachment.

Infant attachment status predicts future development through early adulthood (Grossmann, Grossmann, Winter, & Zimmermann, 2002; Sroufe, Egeland, Carlson, & Collins, 2005; Waters, Merrick, Treboux, Crowell, & Albersheim, 2000). Infant disorganized attachment is of particular interest to clinicians because it is (1) an aspect of general psychopathology, (2) predictive of childhood psychopathology, and (3) predictive of dissociation in young adults. Despite important recent progress in understanding disorganized attachment, we still lack a full understanding of the mechanisms of disorganized attachment formation and transmission prior to 12 months.

In this paper we lay out our recommendations for the study of the 4-month origins of disorganized attachment. In our subsequent Paper II we report on the results of a large empirical study that was conducted along the lines we recommend in Paper I. Both Papers I and II are based on Beebe et al. (2010). In Paper I we propose that a detailed second-by-second microanalysis of 4-month mother–infant face-to-face communication would further inform our understanding of the process of disorganized attachment formation between mother and infant. Such a microanalysis would allow us to characterize the nature of the 4-month infant’s procedural representations, or emerging “internal working models” of attachment. The details of such an analysis are presented in Paper II. Important as they are, the contributions of maternal states of mind, infant temperament, and the regulation of sleep–wake, feeding, and alone states to the origins of attachment lie beyond our scope.

In this Paper I we review selected empirical and theoretical literature that guides our approach. First we present an overview of what is known about the origins of disorganized attachment prior to 12 months. We then describe our dyadic systems approach to the study of face-to-face communication and its disturbances. Here we include the integration of self- and interactive regulation, and the importance of a multimodal approach to communication. We then describe early interaction patterns of infant procedural forms of self- and object representations which inform the origins of internal working models of attachment.

The attempt to relate 4-month mother-infant face-to-face communication to 12-month attachment assessed by the Strange Situation (Ainsworth, Blehar, Waters, & Wall, 1978) combines two different research paradigms which assess different motivational systems. Ainsworth, herself, however, believed that the two research paradigms are likely to inform one another (Blehar, Lieberman, & Ainsworth, 1977). Both paradigms tap a leading edge of development: a flowering of infant social capacity at 4 months, and a spurt in locomotor capacity enabling physical separation at 12 months (Mahler, Pine, & Bergman, 1975). The 4-month face-to-face interaction task (without toys) is organized around play, with no other goal than mutual enjoyment (Stern, 1985). Nevertheless, infant distress is not uncommon, yielding opportunities to observe how mother and infant manage both distress and enjoyment. The Strange Situation examines the balance between attachment behavior and exploration of the environment in a separation–reunion paradigm (Ainsworth et al., 1978). The extent to which the infant uses the parent as a secure base from which to explore, and as a safe haven when distressed, is central to the evaluation of the infant’s attachment classification.

THE ORIGINS OF DISORGANIZED ATTACHMENT

Attachment Classifications

Ainsworth et al. (1978) suggested that the developing quality of infant attachment at 12 to 18 months is dependent upon the nature of maternal behaviors, particularly in response to the infant’s signals and moods earlier in the first year. Maternal sensitivity promotes a secure relationship in which the infant can use the mother as a base for protection and nurturance as well as for exploration. The insecurely attached infant at 12 to 18 months spends too much or too little time in proximity to the mother or in exploring the environment. A balance between attachment and exploration is thereby upset.

The Strange Situation (Ainsworth et al., 1978), conducted between 12 and 18 months, assesses the balance between attachment and exploration through a series of separations and reunions. It yields four categories of attachment: avoidant (A), secure (B), resistant (C), and disorganized (D). In the *secure* pattern, the mother is sensitive to the infant's needs, and the infant tends to use mother as a secure base, to seek proximity, to maintain contact, to engage in positive social interaction following the reunion, and to recover easily from the separation.

Of the three insecure patterns, our interest here is in disorganized attachment. In the reunion episodes *disorganized/disoriented* (D) infants show incomplete movements and expressions, simultaneous displays of contradictory approach/avoidance patterns, confusion and apprehension, and momentary behavioral stalling, considered a breakdown in behavioral organization (Main & Solomon, 1990; Solomon & George, 1999).

The Prediction of 12-Month Attachment Classifications

An important body of work has used the concept of parental sensitivity during the first year to predict attachment at 12 to 18 months. This work has generally used global, rather than microanalytic, assessments of interactions. Sensitivity involves alertness to infant signals, appropriateness and promptness of response, and capacity to negotiate conflicting goals (Ainsworth et al., 1978). Over 60 studies using global assessments have converged on a picture of interactions in the early months of life that predicts secure versus insecure attachment outcomes (see De Wolff & van IJzendoorn, 1997, for a review). Although a review of this large literature is beyond our scope, we note that mothers of secure infants have been described as more responsive and "sensitive," more consistent and prompt in response to infant distress, more likely to hold their infants, less intrusive, and less tense and irritable. Secure (vs. insecure) infants have been described as more responsive in face-to-face play, better able to elicit responsive caretaking, and more emotionally positive, as well as more able to express distress (Ainsworth et al., 1978; Antonucci & Levitt, 1984; Belsky et al., 1984; Blehar et al., 1977; Grossman, Grossman, Spangler, Seuss, & Unzer, 1985; Isabella & Belsky, 1991; Stayton, Ainsworth, & Main, 1973).

Seifer and Schiller (1995) summarized this literature with the concept that if interactions are characterized as generally sensitive, infants will come to expect that their parents will be available to help modulate states of negative arousal. They argued, however, that this concept remains too general and that despite considerable evidence for cross-generational correspondence of attachment styles from parent to child, there is little empirical understanding of the mechanisms by which this attachment transmission may occur (see also Demos, 2001). In their meta-analysis of this literature, De Wolff and van IJzendoorn (1997) also commented on this "transmission gap," and noted that the modest size of the correlations for parental sensitivity as a predictor of attachment leaves room for additional influences.

Disorganized Attachment

Traditional measures of maternal sensitivity have not predicted disorganized infant attachment, likely due to the diversity of parental profiles within the disorganized group and the lack of detailed behavioral coding (Fonagy, 2001; Lyons-Ruth & Jacobvitz, 2008). However, important progress has been made in the last decade. Mothers of disorganized infants are thought to be

suffering from unresolved loss, abuse, or trauma and to be in a continuing state of fear (Lyons-Ruth, Bronfman, & Parsons, 1999; Main & Hesse, 1990). Maternal behavior within the Ainsworth Strange Situation at 12 or 18 months has been found to be frightened and/or frightening (Lyons-Ruth et al., 1999; Schuengel, Bakermans-Kranenburg & Van IJzendoorn, 1999).

Lyons-Ruth et al. (1999) also found that maternal frightened/frightening behavior occurs in a broader context of atypical, disrupted maternal behaviors within the Ainsworth Strange Situation at 12 to 18 months. These disrupted behaviors were affective communication errors (such as mother positive while infant is distressed), disorientation (frightened expression or sudden loss of affect), and negative-intrusive behaviors (such as mocking or pulling infant's wrist). Only one study explores whether disrupted or frightening behavior begins early in the first year, prior to the 12-month attachment assessment. Kelly, Ueng-McHale, Grienberger and Slade (2003) adapted the coding of 12-month maternal disrupted communication in the Strange Situation (Lyons-Ruth et al., 1999) to 4-month mother-infant face-to-face play and predicted disorganized attachment at 12 months. Miller (2010) also adapted this coding to 4-month face-to-face play and predicted disorganized attachment.

A meta-analysis of 12 studies, based on 851 families, evaluated the strength of associations between anomalous parenting (assessed at 12 and 18 months) and disorganized attachment (Madigan et al., 2006). Anomalous parenting included behaviors such as frightening, threatening (loom), dissociative (haunted voice; deferential/timid), and disrupted (failure to repair, lack of response, insensitive/ communication error). They found that a child who does (vs. does not) experience anomalous parenting is 4 times as likely to be classified as disorganized attachment ($r = .34$). However, they argued that much of the variance remains to be explained, and they suggest that future research should attempt to identify the details of the elusive behaviors of anomalous parenting directly implicated in the development of disorganized attachment, one of our goals.

Lyons-Ruth et al. (1999) suggested that the degree of derailment of communication 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; see also Koos & Gergely, 2001). We pursue this concept in Paper II by translating "little sense of influence" into a pattern in which mothers show lowered contingent coordination with infant behavior. In this pattern, the mother does not predictably adjust to the infant's just prior behavior. When the infant cannot predict what the mother will do, he will have a reduced sense of "influence" or agency. In related work, Schechter and colleagues found that infants of traumatized mothers experienced an increased number of failed bids for maternal engagement in coordinated joint attention (Schechter et al., 2010).

Very little work predicts 12- or 18-month infant disorganized attachment from interactions early in the first year, based on microanalytic coding of videotaped interactions. Tomlinson, Cooper, and Murray (2005) predicted 18-month disorganized attachment from maternal frightened/ frightening behavior and maternal depression at 2 months, using 5-point rating scales of videotaped face-to-face interaction. Jaffe, Beebe, Feldstein, Crown, and Jasnow (2001) predicted 12-month disorganized attachment from 4-month vocal rhythm coordination, coded microanalytically. Whereas midrange degree of interactive contingency (coordination) predicted security, higher and lower degrees predicted disorganized/resistant and avoidant attachment, respectively. Higher contingent coordination increases the predictability of the interaction and was interpreted as excessive monitoring, or "vigilance," an effort by both partners to create

more moment-to-moment predictability. Lower coordination was interpreted as inhibition of monitoring, or withdrawal. Midrange coordination leaves more “space,” more room for uncertainty, initiative, and flexibility within the experience of correspondence and contingency, which is optimal for secure attachment.

Most infant literature has considered higher contingent coordination to be a more optimal pattern (see Dunham & Dunham, 1994; Tarabulsy, Tessier, & Kappas, 1996; Van Egeren, Barratt, & Roach, 2001). But the role of interpersonal contingent coordination in infant development has been unclear (Cohn & Elmore, 1988; Jaffe et al., 2001; Keller, Lohaus, Volker, Capenberg, & Chasiotis, 1999). High coordination (high interactive contingency) has been seen as more optimal for development (Chapple, 1970), or in contrast, 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 both higher and lower degrees of contingent coordination are 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, Culver, Tesman, & Shepard, 1989; Warner, Malloy, Schneider, Knoth, & Wilder, 1987).

A DYADIC SYSTEMS APPROACH TO EARLY FACE-TO-FACE COMMUNICATION IN THE ORIGINS OF WORKING MODELS OF ATTACHMENT

Dyadic Systems Approach to Face-to-Face Communication

We use a *dyadic systems approach* to describe mother–infant face-to-face communication and its disturbances at 4 months. This approach examines the contributions of both infant and mother, and of self- as well as interactive regulation, across multiple communication modalities, to the process of attachment formation (Beebe et al., 2010; Jaffe et al., 2001; Sameroff, 1983; Sander, 1995; Tronick, 1989). Whereas attachment research has focused on maternal antecedents, particularly maternal “sensitivity,” we recommend a dyadic approach, analyzing both infant and mother.

In a dyadic systems view, (a) communication is viewed as *moment-to-moment process*. Moment-to-moment variation provides an essential means of sensing the partner. (b) Each person’s behavior is created in the process of joint coordination. (c) Joint coordination is viewed as *bi-directional*: Each person’s behavior is coordinated with that of the partner. As Sander (1995) described, the infant is not seen as activated by the mother; instead, each individual generates complexly organized primary rhythms of activity, which must be coordinated with the partner. Regulation in the system is based on the capacity for mutual modification of the partners, a bi-directional coordination. (d) Bi-directionality does not assume symmetry; the partners need not affect each other in equal measure or like manner (Beebe & Lachmann, 2002). The mother has greater range, control, and flexibility than the infant. Instead, bi-directional contingencies indicate that both partners actively contribute to the exchange. (e) Interactive exchanges are a product of the *integration of self- and interactive contingency processes*, which are concurrent and reciprocal, each affecting the other (Fogel, 1993; Gianino & Tronick, 1988).

A Contingency Approach to Regulation

The concept of regulation has many definitions (Campos, Frankel, & Camras, 2004; Cole, Martin, & Dennis, 2004; Davidson, Jackson, & Kalin, 2000). Our definition of regulation is contingency, or predictability of behavior over time (Cohn & Tronick, 1988; Sander, 1995). We use the terms “contingency” and “coordination” interchangeably. We have therefore adopted the terms self- and interactive “contingency” to avoid confusion over the many different meanings of the term “regulation,” and particularly of the term “self-regulation.” We nevertheless construe our self- and interactive contingency measures as *forms* of self- and interactive regulation (see Beebe & Lachmann, 2002; Beebe et al., 2007; Beebe et al., 2008; Cohn & Tronick, 1988; Jaffe et al., 2001; Tronick, 1989). Prior research on mother–infant face-to-face interaction has focused on interactive contingency (often termed interactive “regulation” or “coordination”). We recommend the examination of both self- and interactive contingencies, which are rarely integrated within the same theoretical and empirical approach. Although some literature construes contingency as a “positive” feature of interactions, in our use, contingency is a neutral term which acquires meaning only in relation to some other outcome, such as attachment insecurity.

Although our approach is familiar for interactive regulation, it is less so for self-regulation (Thomas & Martin, 1976; Warner et al., 1987). There is little agreement on the definition of self-regulation (Fox, 1994). One frequent definition of self-regulation is the activation/dampening of arousal and capacity to down-regulate negative affect. Kopp (1989) suggested that self-regulation in infancy includes both affect tolerance of positive states as well as the management of distress, expressed through such behaviors as head aversion, non-nutritive sucking, body rubbing, and object focus.

One difficulty is that any of these behaviors can be viewed simultaneously as self-regulatory *and* as aspects of interactive regulation. Thus these very behaviors may operate as interactive influences as well. For example, infant rhythms of touch may have an interactive function, in that the mother coordinates her own touch rhythms with those of her infant; but infant rhythms of touch may also have a self-regulation function. For this reason we propose the use of time-series techniques of statistical analysis, which are designed to disembed self and interactive processes. Time-series methods revolutionized the study of social interaction in the 1980s, allowing an assessment of how predictably a behavior unfolds within the individual (*self-contingency*), as well as how that behavior modifies and is modified by the changing behavior of the partner (*interactive contingency*; see Fogel, 1993; Thomas & Martin, 1976). Time-series methods are designed to partition these two sources of variance. Because any behavior pattern in a face-to-face encounter may participate simultaneously in self- *and* interactive contingency functions, every behavior must be assessed for both functions. Using this approach, the function of a behavior (self- or interactive contingency) is not decided in advance. Instead, both functions may be operative in a particular behavioral pattern. Thus behaviors considered self-regulatory, such as self-touch, or looking away, can be examined for self-contingency, as well as for ways in which self-touch or looking away behaviors may be interpersonally coordinated (interactive contingency).

Predictability of behavior is the most general of the concepts of self-regulation and is a fundamental principle of brain/behavior organization. The brain continuously anticipates changes in the environment and within the organism, on the basis of incoming information (Llinas, 2001; Pally, 2000). The self-contingency (auto-correlation) measure of self-predictability of an individual’s behavior from moment-to-moment taps *one* essential feature of self-regulation but omits

others. *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). It refers to the degree of predictability (in a range from stability to lability) within an individual's own rhythms of activity. Self-contingency provides the individual with continuous procedural information about the likelihood of staying in the same state.

Our approach to self- and interactive contingency can be construed as an examination of the contingencies of *intrapersonal* and *interpersonal rhythms* within a face-to-face encounter. Social behavior unfolds in time in an ongoing patterned format, loosely rhythmic. Although the simplest rhythms are strictly regular (periodic), the rhythms of human communicative behavior are irregular (nonperiodic), based on a recurrent nonrandom temporal patterning (Cohn & Tronick, 1988; Feldman, 2006; Jaffe et al., 2001; Lashley, 1954). Mother–infant interaction is organized through loosely organized repeating rhythmic cycles (Feldman, 2006; Jaffe et al., 2001; Stern, 1985). Self-contingency measures the predictability of these loose behavioral rhythms within an individual. Behavioral forms of self-regulation are originally grounded in basic biological rhythms, such as those of breathing (Feldman, 2006). Interactive contingency measures the degree to which the loose rhythms within an individual can be predicted from those of the partner. In social interactions, *both* intrapersonal and interpersonal rhythms provide ongoing temporal information necessary to predict and coordinate with one's partner, so that each can anticipate how the other will proceed (Warner et al., 1987). In these definitions of self- and interactive contingency, both one's own and the partner's behaviors can be predicted from immediately prior behaviors. However, the series as a whole does not follow a predetermined regularity, so that each individual is open to his own changing behavior and that of the partner (Cohn & Tronick, 1988; Feldman, 2006; Gottman, 1981). The integration of self- and interactive contingency is a key feature of our proposal.

The Advantage of a Dyadic Systems Approach to the Origins of Attachment

A dyadic systems approach has not been adequately exploited in the study of the origins of attachment (Seifer & Schiller, 1995; but see Jaffe et al., 2001). There is a tendency to locate the source of difficulty in one partner or the other, for example, in early infant self-regulatory difficulties, or in maternal insensitivity, rather than to evaluate the contributions of both partners. We recommend the latter. Bowlby (1958, 1969) himself held a systems view in his study of the origins of attachment. Both mother and child contribute in essential ways to the regulation of the attachment relationship. However, Fox (1994) noted that while notions of reciprocal regulatory control were central to Bowlby's thinking, they have not been so in research on the origins of attachment.

Thus, whereas attachment research has focused on maternal antecedents of infant attachment, particularly "sensitivity," our approach examines the dyad, analyzing both infant and mother. The infant's experience will be shaped not only by the parent's patterns of behavior, but also by his own. Greater emphasis on the infant's active role in organizing information and behavior, and on the contributions of contingently organized infant as well as maternal coordination, is needed in the prediction of infant attachment outcomes (Jaffe et al., 2001; Tarabulsky et al., 1996).

The dyadic systems view of face-to-face communication which we propose is more narrow, but nevertheless consistent with, broader dynamic systems views of development, which also hold

that components of a system (here, mother and infant) are in a continuous process of bidirectional exchange. Many current versions of systems theories of development view the mechanism of development as a mutual interdependence between an actively perceiving infant and its structured environment (Gottlieb, Wahlsten, & Lickliter 1998; Lerner, 1998; Lewkowicz, 2000; van Geert, 1998). Bidirectional reciprocal coordinations are a primary basis for promoting the system's development. Although bidirectional exchange is a major theme of research on mother–infant face-to-face exchange, its value for predicting attachment has not been sufficiently explored.

The Integration of Content and Process in the Organization of the Dyadic System

Prior attachment research has focused more on *content* measures of qualitative features of behavior (such as prevalence of maternal sensitivity) than on measures of the *temporal process of relating* (such as self- and interactive contingencies). We recommend both content and process measures (see Kaitz & Maytal, 2005). Although there are many methods of assessing moment-to-moment process, we favor time-series approaches because they are specifically designed to evaluate both self- and interactive contingency. Time-series approaches address the moment-to-moment sequence of behaviors across the entire segment of the face-to-face play session that is analyzed, rather than specific sequences of behaviors, such as maternal smile follows infant smile. For example, maternal facial affect interactive contingency measures how closely the mother coordinates (correlates) her entire range of facial affect changes (from positive to negative) with the infant's just prior facial affect changes, "going with" the infant's direction of affective change across the session.

Contingency measures have received less attention than "content" measures of *qualitative features of behavior* per se. Measures of qualitative features, such as percentage of time that mothers engage in intrusive touch, are rates of specific behaviors that are taken out of time, and in so doing, sequence is lost. We propose that mother and infant self- and interactive contingency, as well as specific qualitative features of behavior should be studied as mechanisms of attachment formation and transmission by 4 months.

In order to create measures of contingency, which address moment-to-moment process, a microanalytic approach coding small units of time, such as second-by-second, is required. Whereas prior attachment research has tended to use global ratings of maternal sensitivity (de Wolf & van Ijzendoorn, 1997), the microanalytic approaches that we recommend generate far greater specificity of description.

Communication Modalities

Face-to-face communication generates multiple simultaneous emotional signals. Infants are sensitive to all modalities and are capable of coordinating them to apprehend affective states (Murray & Cooper, 1997; Stern, 1985; Trevarthen, 1998; Tronick, 1989). Multiple modalities typically convey temporally coordinated, congruent information (Bahrack & Lickliter, 2002). Redundancy and overlap facilitate attention, learning, and memory. However, with disturbed communication, different modalities can convey discordant information, difficult to integrate into a coherent percept (Shackman & Pollack, 2005). We recommend coding of separate communication modalities in an effort to identify such discordances. Discordances were salient in our

prior work on associations of maternal depression, anxiety, and self-criticism with mother–infant communication (see Beebe et al., 2007; Beebe et al., 2008; Beebe et al., 2011). For example, depressed mothers and their infants showed a discordant pattern of lowered coordination of gaze (at or away from the partner’s face), but heightened facial/vocal affect coordination. This result would not be detectable if gaze and affect were assessed as a composite (Beebe et al., 2008), rather than as separate communication modalities.

Composite multimodal measures of “engagement” combine modalities such as infant orientation to the partner (from en face to arch), visual attention (gaze at or away from partner’s face), and positive to negative facial and vocal affect (see Beebe & Gerstman, 1980; Cohn & Tronick, 1988). Although composite measures are often used in research on mother–infant face-to-face communication, only examination of separate modalities can identify potential discordant communication, as well as specify exactly which modalities of communication may be involved in the development of insecure attachment (Van Egeren et al., 2001; Weinberg & Tronick, 1996). On the other hand, only a composite measure provides a wholistic, gestalt approach to capturing the quality of the interaction. We recommend both composite measures and the coding of separate modalities. Although affect regulation has been seen as central to attachment (Schore, 1994), we recommend a broadened focus, attempting to identify dysregulations of visual attention, spatial orientation, and touch, as well as affect.

Thus in investigating associations of 4-month mother–infant face-to-face interaction with 12-month disorganized attachment, we propose 4-month measures of qualitative features of behaviors, as well as contingency of behaviors. Using mother and infant self- and interactive contingency to predict disorganized attachment, we recommend the investigation of (a) which partner (mother or infant) may show 4-month degree of contingency which differs from that of secure dyads; (b) whether contingency is increased, or decreased, relative to secure dyads; (c) the type of contingency that is altered, self- or interactive; and (d) the communication modality in which contingency is altered. Those 4-month measures of contingency and qualitative behavioral features which successfully predict 12-month disorganized attachment can then be used to conceptualize emerging 4-month infant “internal working models” associated with disorganized attachment, based on infant procedural expectancies of sequences of events.

EARLY INTERACTION PATTERNS OF INFANT PROCEDURAL FORMS OF SELF – AND OBJECT REPRESENTATIONS

Representations Inform the Origins of Internal Working Models

The literature on “internal working models” of attachment, based on procedural expectancies of actual experiences (see Main, Kaplan, & Cassidy, 1985), and a parallel literature on the origins of procedural forms of “self and object representations” (see Beebe & Lachmann, 2002), have proceeded largely separately. An integration will facilitate our ability to conceptualize the origins of disorganized attachment. Bowlby and subsequent attachment researchers suggested that the recurrent nature of the infant’s experiences leads to the development of internal representations or “working models” of self and others, generalized representations of events, that influence the infant’s emotional expectations throughout development (Bowlby, 1969; Bretherton & Munholland, 1999; Main et al., 1985). Consistent with this view, a large empirical

literature documents that variations in social interactions in the first months, which generate infant expectancies of recurrent events, predict later social and cognitive outcomes (see Beebe & Lachmann, 2002, for a review).

Main et al. (1985) define internal working models as “a set of conscious or unconscious rules for the organization of information relevant to attachment . . . which leads to individual differences in the mental representation of the self in relation to attachment” (p. 67). We note that these rules may be conscious; unconscious, in the sense of the dynamic unconscious; or nonconscious, in the sense of implicit, procedural processing. These internal models of relationships “direct not only feelings and behavior, but also attention, memory, and cognition,” leading ultimately to differences in patterns of language and structures of mind (Main et al., 1985, p. 67). Although attachment researchers argue that internal working models provide one process by which patterns of intimate relating and attachment security are constructed, our understanding of the details of these models remains rudimentary. Explication of these details is urgently needed to further understand the origins of internal working models in the first half year of life.

Infant Perception of Expectancies

The concept of internal working model from the attachment literature is consistent with experimental perception and cognition literature on infant contingency perception and procedural representation. The infant has intrinsic motivation to detect pattern and order, to generate procedural expectancies, and to act on these expectancies (Haith, Hazan, & Goodman, 1988; Mandler, 1988). The infant is involved in an active process of ordering and reordering information. Infants have remarkable capacities to detect regularities in events, to perceive contingency and degree of contingency, and to expect when events will occur, by estimating probabilities of “if-then” sequences (Saffran, Aslin, & Newport, 1996).

The perception of contingent relations allows infants 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 (Beebe & Lachmann, 2002; Jaffe et al., 2001; Stern, 1985; Tarabulsy et al., 1996). Infant procedural representational capacities in the first 3 to 4 months are extensive (Bornstein, 1985; Haith et al., 1988; Lewkowicz, 2000; Shields & Rovee-Collier, 1992; Singer & Fagen, 1992).

Mother and Infant Social Expectancies

The nature of each partner’s contingent coordination with the other affects the infant’s ability to attend, process information, and modulate behavior and emotional state. These reciprocal contingency processes are essential to the creation of infant and maternal social expectancies and interactive efficacy, and to infant social and cognitive development (Hay, 1997; Lewis & Goldberg, 1969; Murray & Cooper, 1997; Stern, 1985; Trevarthen, 1998; Tronick, 1989). Both partners anticipate in detail what the other will do. The infant experiences being experienced (Beebe, Knoblauch, Rustin, & Sorter, 2005).

Using these capacities, infants generate “expectancies,” procedural “self and object representations,” or “internal working models” of recurrent and characteristic interaction patterns. Although these terms derive from different research traditions, they all have the same basic

referent. In describing the infant's experience of these expectancies or models, we draw on systems concepts. These early procedural social representations are inherently dyadic and cannot be described on the basis of either partner alone (Beebe & Lachmann, 2002; Beebe & Stern, 1977; Bowlby, 1969). The infant represents the moment-to-moment dynamic interplay of his own actions-in-relation-to-the-actions of the other.

Interaction Patterns of Infant Procedural Representation Inform the Origins of Infant Internal Working Models

Thus prior to the emergence of symbolic forms of representation, a presymbolic representational social world is being organized. In describing the organization of early procedural interactive representations, we (Beebe & Lachmann, 2002; Beebe & Stern, 1977) have suggested that infants will come to expect and represent models of how interactions unfold in the dimensions of time, space, affect, and arousal. In the dimension of time infants represent the rate, rhythm, sequence, and tightness of contingency of the behaviors. In the dimension of space infants represent patterns of mutual approach–approach or approach–avoid. In the dimension of facial affect infants represent the pattern of moving in the same direction (facial mirroring) or not, the positive and negative tones of faces and voices, and whether these are shared. Infants also represent an associated arousal pattern, the proprioceptive experience of their movements over time, and the degree of predictability of their movements.

Examples of interaction patterns that organize infant procedural social representations in our work (Beebe & Lachmann, 2002) include (1) state transforming, the expectation of being able to transform an arousal state through the contribution of the partner (see Stern, 1985); (2) facial mirroring, the expectation of matching and being matched in the direction of affective change (positive and negative), providing each partner with a behavioral basis for entering into the other's feeling state, and generating experiences which contribute to feeling “known,” attuned to, or “on the same wave length;” (3) disruption and repair, the expectation of degree of ease and rapidity of interactive repair following facial-visual mismatches (Beebe & Lachmann, 2002; Tronick, 1989); (4) “chase and dodge,” the expectation of the misregulation and derailment of spatial-orientation patterns, without repair (Beebe & Lachmann, 2002; Beebe & Stern, 1977); and (5) interpersonal timing, the expectation of degree of contingent coordination, from low (“withdrawn”), to midrange, to high (“vigilant”), generating expectancies of the degree to which the partner responds to the self, and the self responds to the partner (see Jaffe et al., 2001).

Although the above descriptions focus on the infant's experience, the inherently dyadic nature of these representations implies that both roles are known to both people (Beebe & Lachmann, 2002). These procedural representations are a mutually organized and mutually understood code. Any role implies its reciprocal, and neither role can be represented without the other. This may explain why infants classified as disorganized attachment at one year, who may feel controlled by the mother, may later develop a controlling style themselves (Lyons-Ruth & Jacobvitz, 2008).

Three Principles of Salience in the Organization of Infant Procedural Representations Inform the Origins of Internal Working Models

In considering what general principles may determine the centrality of social events for the infant, we proposed three “principles of salience,” which constitute criteria by which interactions may be

categorized and represented (Beebe & Lachmann, 2002). These principles of salience move from the specific content of interaction patterns to a description of the *process*. Is it the infant's recognition of what is regular, predictable and "invariant" in his interactions that becomes salient? This is the principle of *ongoing regulations*. Findings which might emerge from analyses describing contingency patterns of future disorganized (vs. secure) dyads across the entire section of interaction analyzed would fit the principle of ongoing regulations.

Or, is it the infant's recognition that something changes, disrupts his interactions, or violates his expectancies, and the subsequent effort to repair the disruption, that organizes his experience? This is the principle of *disruption and repair*. Or, is it the power of heightened affective moments that "colors" and thus organizes infant experience? This is the principle of *heightened affective moments*, in which a dramatic moment, positive or negative, becomes formative far out of proportion to mere temporal duration (see Pine, 1981). Findings that might emerge from analyses of specific behavioral qualities, such as rates of infant "whimper" vocalizations, would fit the principle of heightened affective moments. These principles would illuminate the nature of interactive disturbances in the origins of disorganized attachment.

PROCEDURAL MECHANISMS OF SENSING THE STATE OF THE OTHER

Sensing the State of the Other From the Point of View of the Infant: Correspondences and Shared States

We argued above that the recurrent nature of the infant's experiences leads to the development of internal representations or "working models" of self and others, generalized representations of events, that influence the infant's emotional expectations and create internal working models of attachment. As these infant expectancies are created, to what degree can the infant sense the state of the mother? In what follows we review the ways in which infants may perceive the state of the partner, and perceive whether the states of infant and partner are shared, based on the work of Meltzoff (1990, 2007), Trevarthen (1998), Stern (1985), and Sander (1995). They converge on a similar understanding of the role of correspondences in the creation of shared states, but each theorist makes a unique contribution. In the origins of disorganized attachment, various kinds of disturbances in shared states are possible.

In creating models of social interactions, infants apprehend correspondences between body transformations that they see (such as the partner's mouth opening), and their own body transformations (such as their own mouth opening) that they do not see. Meltzoff has used imitation experiments in the first weeks of life to argue that infants are biologically prepared to perceive cross-modal correspondences of form, between what they see on the face of the partner and what they sense proprioceptively on their own faces (Meltzoff, 1990, 2007; see also Bahrack & Watson, 1985; Beebe et al., 2005). In Meltzoff's view, the infant's perception of correspondences between his own behavior and that of his partner provides the infant with a fundamental relatedness between self and other. Moreover, infants represent these actions (Meltzoff, 1990). This representation constitutes a model against which the infant can match his own performance and guide his behavior. Through the perception of cross-modal correspondences, both infant and partner can sense the state of the other, and sense whether the state is shared. In essence, the infant can determine whether *that* (perceived in the other) looks like *this feels* (perceived in the self; Meltzoff, 2007).

Stern describes correspondence as a reciprocal dyadic process across time: each *changes with* the other. Trevarthen (1998) held that social patterns are contingently coupled in time, imitated in form, and brought into register in intensity range. The particular temporal-spatial-intensity patterns formed by the dyad will guide actions, tune each to notice and remember them, and affect procedural representations. Meltzoff, Trevarthen, and Stern all agree that the infant's capacity to recognize cross-modal correspondences is the central mechanism allowing the infant to capture the quality of another's inner feeling state.

Stern's (1985) work explicitly links cross-modal correspondences and shared states to infant attachment. Affect attunement is defined as the crossmodal matching of intensity, timing, and "shape" (contour) of behavior, based on dynamic micromomentary shifts over time, perceived as patterns of change that are similar in self and other (Stern, Hofer, Haft, & Dore, 1985). In this process, the infant captures the quality of another's feeling state, and discriminates whether it is shared. Stern argued that processes of affect attunement are so powerful because they contribute to attachment security and the capacity for intimacy. The individual learns that some subjective states are shareable, and some are not. Both Trevarthen and Stern saw the origin of mind in the interactive process itself.

Sander's (1995) concept of "matched specificities" is useful in further elaborating the meaning of correspondences. Sander defined this concept as a "sort of resonance between two systems attuned to each other by corresponding properties" (Weiss, 1970, p. 162). An example might be similar vocal rhythms in mother and infant. In Sander's view, the presence of matched specificities yields procedural awareness in each partner of the state of the other. This concept underlies Sander's "moment of meeting," a match between two partners such that the way one is known by oneself is matched by the way one is known by the other. This match facilitates the development of agency, identity, and coherence in the child's experience (Sander, 1995; Stern, 1985).

Thus, the central hypothesis of this literature is that disturbances in correspondences, particularly affective correspondences, will be central to mother-infant communication disturbances and difficulties in sensing the state of the other. As important as disturbances in affective correspondences are, in contrast we propose that there may be many other kinds of difficulties in sensing the state of the other, based on dysregulations in attention, spatial orientation, and touch, as well as affect.

Sensing the State of the Other From the Point of View of the Mother

As mothers interact with their infants, the recurrent nature of the mother's experiences also leads to the development of internal representations or "working models" of self and infant. But the maternal representations of events are also highly influenced by the internal working models that she has previously developed across her own lifetime. Mothers of disorganized infants have been found to suffer from unresolved loss, mourning, or abuse (Main & Hesse, 1990). This finding is essential in understanding any communication disturbances in disorganized attachment dyads.

To set the stage for understanding mothers of infants who will be disorganized, we address the adult literature on procedural mechanisms of sensing the state of the other. As maternal expectancies are created, to what degree can the mother sense the state of the infant? 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; Hodges & Wegner, 1997; Peck, 2003). As partners match each other’s affective patterns, by matching the direction of affective change (positive to negative), each re-creates a psychophysiological state in the self similar to that of the partner, an additional way of participating in the subjective state of the other (Beebe & Lachmann, 2002; Ekman, Levenson, & Friesen, 1983; Levenson, Ekman, & Friesen, 1990). Thus, mothers who do not participate in patterns of matching the other’s direction of affective change would not be able to re-create in themselves the psychophysiological state of the infant. In turn, this difficulty would disturb the mother’s empathy with the infant’s affective fluctuations.

KNOWING AND BEING KNOWN BY ANOTHER’S MIND

As the infant’s recurrent experiences lead to the formations of procedural representations or “working models” of self and others, what is at stake is the organization of intimate relating, which entails the fundamental issue of how the infant comes to know, and feel known by, another’s mind (Lyons-Ruth, 1999, 2008). This is similar to Stern’s (1985) argument that the infant learns that some subjective states are shareable, and some are not, and that this learning powerfully affects attachment security and the capacity for intimacy. Learning which states are shareable, and which are not, defines the arenas in which one can, and cannot, know and feel known by another’s mind.

Collaborative Dialogues

Lyons-Ruth (1999, 2008) proposed that the outcome of the process of coming to know and feel known by another’s mind is dependent on whether the partner is capable of a *collaborative dialogue*. Collaborative dialogue involves close attention to the other’s initiatives; openness to the other’s state across the entire range of positive to negative emotions; attempts to comprehend the state, goal, or subjective reality of the other; the attempt to respond in a way that acknowledges, elaborates, or comments on that state; ability to negotiate similarity and difference; and efforts to repair disruptions. Such dialogues generate collaborative internal models in which both partners are represented as open to the experience of the other; each can know and feel known by the partner’s mind.

Contradictory Dialogues

Lyons-Ruth (1999) further suggested that incoherent or contradictory dialogues involve a collapse of intersubjective space in which only one person’s subjective reality is recognized. The partner’s initiatives are ignored, overridden, or not acknowledged. Such failures of collaborative dialogue generate contradictory internal models, in which the partner represents both roles, such as “I should accept your control; I should attempt to control you.” As we see in Paper II, the issue of collaborative versus contradictory dialogues is central in the origins of disorganized attachment.

To understand contradictory dialogues, Lyons-Ruth (1999) described how complex “control systems” for skilled actions, such as communicating, are developed by coordinating single relational procedures, such as facial affect, with other procedures, such as vocal affect, from second to second. The flexible integration of these procedures is essential to higher-order coordinations. However, when procedures conflict, such as simultaneous positive facial affect but negative vocal affect, the lack of integration can disturb domains of procedural knowledge and the development of flexible control systems. This description of unintegrated domains of knowledge is consistent with the concept of intermodal discordances, in which contradictory procedures are organized in different communication modalities at the same time, or in rapid succession, and are difficult to integrate into a coherent percept (Shackman & Pollack, 2005). Thus we propose that intermodal discrepancies and contradictory dialogues are an important area of investigation in the origins of disorganized attachment.

CONCLUSION

We proposed the following concepts to guide our empirical analysis of the origins of internal working models of attachment at 4 months in infants who will be classified as disorganized attachment at 12 months, which is presented in Paper II.

1. The concept of internal working model is consistent with experimental literature showing that infants have *intrinsic* motivation to detect pattern and contingent relations, and to generate procedural expectancies of the recurrence of events. Infants thus generate expectancies, procedural representations, or “internal working models” of recurrent interaction patterns.
2. Various interaction patterns documented in the literature on mother–infant face-to-face interaction can potentially inform the details of infant working models of attachment, if it can be shown that these patterns predict attachment outcomes. Infant procedural representations of face-to-face interactions include patterns such as (a) state-transforming, (b) facial mirroring and more generally affective correspondences, (c) disruption and repair, (d) mutual approach or approach/avoid spatial orientation, and (e) degrees of interpersonal contingency (withdrawn, optimal midrange, and vigilant).
3. Through the perception of correspondences between one’s own behavior and that of the partner, both infant and partner can sense the state of the other, and can sense whether the state is shared or not. The central hypothesis from this literature is that disturbances in correspondences, and particularly in affective correspondences, will be central to mother–infant difficulties in sensing the state of the other. But we propose that there may be many different kinds of difficulties in sensing the state of the other, based on dysregulations in attention, touch, and spatial orientation, as well as affect.
4. We proposed that intermodal discrepancies will be central in mother–infant communication disturbances relevant to disorganized attachment. When contradictory procedures are organized in different communication modalities, often generating intermodal discrepancies, unintegrated and conflicting procedural representations are likely to develop. Collaborative, in contrast to contradictory, dialogues generate coherent rather than unintegrated infant internal working models of attachment.

5. What is at stake in these procedural representations is the organization of intimate relating, which entails the fundamental issue of how the infant comes to know, and to feel known by, another's mind.

In Paper II we will use the framework just described in Paper I to guide an empirical analysis of the origins of disorganized attachment. Examining an urban community sample, and using a detailed second-by-second microanalysis of 4-month mother–infant face-to-face communication, we predicted 12-month infant disorganized (vs. secure) attachment outcomes. As we will detail in Paper II, we documented a complex dyadic systems view of the roles of both partners, the roles of both self- and interactive contingency, and the importance of attention, orientation and touch, and as well as facial and vocal affect, in the co-construction of attachment disorganization.

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