Title
An Examination of Changes in Emotion Co-Regulation Among Mother and Child Dyads During the Strange Situation.

Permalink
https://escholarship.org/uc/item/6k05w5wt

Journal
Infant and child development, 24(3)

ISSN
1522-7227

Authors
Guo, Yuqing
Leu, Szu-Yun
Barnard, Kathryn E
et al.

Publication Date
2015-05-14

Copyright Information

Peer reviewed

An Examination of Changes in Emotion Co-Regulation Among Mother and Child Dyads During the Strange Situation

Yuqing Guo, Ph.D., RN[a], **Szu-Yun Leu, Ph.D.**[b], **Kathryn E. Barnard, Ph.D., RN**[c], **Elaine A Thompson, Ph.D., RN**[c], and **Susan J. Spieker, Ph.D.**[c]

[a]University of California Irvine, Program in Nursing Science, Irvine, CA

[b]University of California Irvine, Institute for Clinical and Translational Science and School of Medicine, Department of Pediatrics

[c]University of Washington, School of Nursing, Seattle, WA

Abstract

The present study applied State Space Grid analysis to describe how preschooler-mother dyads co-regulate emotion in the Strange Situation. Second-to-second mother and child affect during pre-separation play (baseline) and the final reunion (post perturbation) episodes of the Strange Situation were coded for 80 dyads. Change in emotion co-regulation across the two Strange Situation episodes was examined with linear mixed models for groups with secure and insecure classifications. The groups did not differ at baseline. Change in content-specific emotion co-regulation but not content-free emotion co-regulation was found to be significantly different within and between groups. Both secure and insecure dyads reduced the time spent in positive interaction but increased the time in negative interaction across two episodes; the change in secure dyads was less pronounced than in the insecure dyads. After the separation, secure dyads had more positive interactions and fewer negative interactions compared to insecure dyads. Results highlight how secure dyads adapted to the stressful change, whereas insecure dyads were more reactive and less resilient to the stress of the study's brief imposed separation.

Keywords

emotion co-regulation; dynamic systems; mother-child dyads

The acquisition of emotion regulation is of central concern in studies of how children meet developmental milestones (Kopp, 1989). During emotional development in young children, parents play a crucial role in regulating their children's emotional experience, and in turn, children also evoke emotion in their parents (Eisenberg, Spinrad, & Eggum, 2010). Of particular importance but rarely examined is the reciprocal emotional interaction of both parent and child when they are experiencing stress that activates the child's attachment system, as in the Strange Situation. This study describes how preschooler-mother dyads co-

---

Address of the Corresponding Author: Yuqing Guo, PhD, RN, Assistant Professor, Program in Nursing Science, University of California, Irvine, 299D, Berk Hall, Irvine, CA, 92697-3959, Office: 949-824-9057, Fax: 949-824-0470 gyuqing@uci.edu.

regulate emotion in the Strange Situation, thus adding to the extant research in this important area.

Attachment theory and research support the premise that patterns of emotion regulation are established in early attachment relationships (Cassidy, 1994; Sroufe, 1996, 2005). In other words, early attachment experiences provide an important context for children to develop and internalize more complex regulatory functions (Sroufe, 2005). Children considered to have secure attachment have more positive attachment experiences that enable them to actively and constructively express negative emotions and receive caregiver comfort to resolve them, while children considered to have insecure attachment are more likely to inhibit or exaggerate negative displays, which fall short of eliciting the comfort they desire (Etzion-Carasso & Oppenheim, 2000; Kochanska, 2001; Main, Kaplan, & Cassidy, 1985; Matas, Arend, & Sroufe, 1978; Mikulincer, Shaver, & Pereg, 2003; Pastor, 1981).

The Strange Situation procedure is a widely used observational assessment of toddler-parent and preschooler-parent attachment relationships that uses two brief separation episodes to activate the child's attachment system (Ainsworth, Blehar, Waters, & Wall, 1978). Studies examining emotion regulation in the Strange Situation have focused almost exclusively on children's responses. Shiller et al. (1986) examined how infants' emotional reactions to separation corresponded to the classification of their attachment behaviors (avoidant, secure, and resistant). Children in the three classification groups did not differ in the proportion of time they displayed anger; however, resistant infants displayed more sadness and less interest than secure infants. Connell and Thompson (1986) investigated the relation between emotion and social interaction in the Strange Situation. Infant negative emotion in the final separation episode predicted social interaction behavior with mother (proximity seeking, contact maintaining, and resistance to interaction) in the subsequent reunion episode.

The above studies provide evidence that children's emotions may play a critical role in regulating interactive behavior with their mothers in the Strange Situation. On the other hand, how mothers influenced their children's emotional responses was not addressed. According to attachment theory, individual differences in the quality of attachment relationships are built gradually over a history of emotional bids and responses within the dyad (Weinfield, Sroufe, & Egeland, 1999). Thus, a mother's responses are critical to her child's emotion regulation. Sroufe (1996) contends that dyadic emotion regulation is the key, and it is essential to include both mother's and child's emotional expression when studying emotion regulation in the Strange Situation. A limitation of previous studies is that only infants and toddlers have been the focus. From a developmental perspective, children have some ability to describe their own and others' emotions, to articulate the causes and consequences of their own and others' feelings, and to employ emotions for manipulative purposes by the age of three (Bretherton, 1986; Denham, 1998; Ridgeway, Waters, & Kuczaj, 1985). Still, at three years old, a child will still have only limited ability to self-regulate emotion (Ashiabi, 2000; Diamond & Aspinwall, 2003).

Emotion Co-Regulation

The ability to regulate one's emotions and act in accord with social standards is one of the critical hallmarks of child development (Kochanska, Coy, & Murray, 2001). Research involving children's regulatory capacity has expanded dramatically in the last three decades. Despite a variety of definitions of emotion regulation, there is consensus that emotion regulation is a process enabling individuals to modulate their experience and expression of positive and negative emotion (Bridges, Denham, & Ganiban, 2004; Calkins, 1994; Eisenberg & Spinrad, 2004; Gross, 1998; Thompson, 1994). Children's regulatory ability develops through their interactions with caregivers. Parents facilitate acquisition of emotion regulation skills by labeling their children's emotional expressions, validating their children's emotional experiences, and providing strategies to modulate emotional arousal within the relational context (Fox, 1998). In addition to the prominent role parents play in the emotional development of their children, children also make active contributions to their interactions with parents. An example of this is the assessment of infant responses after the perturbation in the "Still Face" experiment. The Still Face is a well-validated procedure that demonstrates how an infant uses different strategies to resume reciprocal engagement with his or her mother after the mother suddenly appears unresponsive and unavailable (Tronick, Als, Adamson, Wise, & Brazelton, 1978).

Parent-child interaction has been found to be a bi-directional system where both partners are shaped by each other's state and signals (Barnard, 1976; Feldman, 2003; Stern, 1985; Tronick, 1989). In this mutually regulating system, infants have the innate ability to alter their state in response to maternal behavior, and the mother attunes her behavior to her infant's emotional state (Tronick, 2007). Emotion co-regulation refers to a parent's and child's shared gaze, matched or complementary affective states, contingent exchange of vocalization and interactive behavior, and dyadic mutuality (Cole, Teti, & Zahn-Waxler, 2003; Deater-Deckard, Atzaba-Poria & Pike, 2004; Dumas, LaFreniere, & Serketich, 1995; Lavelli & Fogel, 2005; Tronick, Als, & Brazelton, 1977). Given the emphasis on the relational nature of emotion regulation, there have been multiple approaches to operationalizing this concept. For example, investigators (NICHD Early Child Care Research Network [ECCRN], 2004) coded children's emotions in mother-child interactions during a minimally stressful play session and a potentially more stressful toy cleanup episode. Children's behavior was classified as affect-dysregulated if they displayed high negative affect in either context. Wilson and Durbin (2013) measured individual mother and child bids and the partner's responsiveness to these bids to approximate mutual emotion regulation. Deater-Deckard and Petrill (2004) operationalized cooperation and reciprocity of parent-child interaction using a Likert scale rating system. Recently, developmental researchers have conjectured that dynamic systems methods could shed new light on emotional development by capturing the processes that emerge from momentary shifts of the system (Fogel, 2011; Hollenstein, 2011; Lewis, 2011).

Dynamic Systems Approach

There is evidence that an application of the dynamic systems approach to co-regulation reveals fine-grained interactive patterns. For example, Tronick and Cohn (1989) found that

normal mother-infant dyads spent 70% of their interaction time in dis-synchronous states. The process of dyadic repair that follows these states involves transitioning from a miscoordinated state to a coordinated state (indicated by the extent of matching and synchrony). It is through such interpersonal reparation that an infant develops a sense of self and an ability to regulate states during social interaction (Tronick, Ricks, & Cohn, 1982). Recently, a novel dynamic systems analytic approach, known as State Space Grids (SSG), was created to quantify dyadic interaction as one unit of analysis (Lamey, Hollenstein, Lewis, & Granic, 2004). In the case of emotion co-regulation, the grid represents all possible combinations of two individuals' emotions within the flow of their interaction. One of the most important contributions of SSG is to make it feasible to operationalize both content-free and content-specific emotion co-regulation. For example, dyadic flexibility (an indicator of content-free emotion co-regulation) can be operationalized with such SSG variables as the range of the emotional repertoire and the tendency to perseverate in each state. Specifically, flexible emotion co-regulation would be indicated by more emotional states displayed during parent-child interactions and a tendency to remain in each emotional state for less time (Granic, O'Hara, Pepler, & Lewis, 2007; Hollenstein, Granic, Stoolmiller, & Snyder, 2004; Lunkenheimer, Albrecht & Kempt, 2013; Lunkenheimer, Olson, Hollenstein, Sameroff, & Winter, 2011; Sravish, Tronick, Hollenstein, & Beeghly, 2013).

Children may learn to modulate emotions when parents accept a variety of emotions and coach children how to express and manage them (Gottman, Katz, & Hooven, 1996; Lunkenheimer, Hollenstein, Wang, & Shields, 2012). Lunkenheimer and colleagues (2011) found that dyadic flexibility and shared positive affect states interacted to predict teachers' lower ratings of child externalizing behaviors. Similarly, less flexible or rigid parent-child interaction has been found to predict externalizing and internalizing behaviors in at-risk children (Hollenstein et al., 2004; Lunkenheimer et al., 2013), a finding corroborated by other researchers (Dishion, Nelson, Bullock, & Winter, 2004; Patterson, 1982). Altogether, these findings suggest the importance of investigating both content-free and content-specific co-regulation in real time, in order to understand how changes in interpersonal structure uniquely combine with emotional content in response to changing environmental demands (Hollenstein et al., 2004).

Purpose and Hypotheses of the Present Study

According to dynamic systems theory, individual differences in the underlying structure of interpersonal emotion regulation should be revealed after a perturbation to the system (Granic & Patterson, 2006). In recent research using SSG, Sravish et al. (2013) examined infant-mother co-regulation in the context of the Still Face paradigm. Dyadic flexibility increased from the initial play to the reunion play episode. In the Strange Situation, the pre-separation play episode, with only mother and child in the room, serves as the emotion co-regulation baseline. Then, two brief departures of the mother, leaving the child alone and returning, activate attachment behavior in young children. The second separation is the most activating of the attachment system because it adds to the stress of the first. The second separation serves as the perturbation prompting dyads to reorganize their interaction. The final reunion episode provides an opportunity to observe the underlying emotion co-regulation structure. The purpose of the present study was to use SSG to describe real-time

changes in emotion co-regulation in the baseline and final reunion episodes of the Strange Situation, in dyads of mothers and preschoolers. We observed the child's and mother's moment-to-moment affective displays in both episodes and operationalized emotion co-regulation as dyadic flexibility, dyadic negative affect, and dyadic positive affect, as defined in prior studies using SSG (Granic et al., 2007; Hollenstein et al., 2006; Lunkenheimer et al., 2011; Lunkenheimer et al., 2013).

Prior research indicates that parent-child interaction patterns differ for children whose behavior in the Strange Situation is classified as secure or insecure. Theoretically, a secure child is one who openly communicates both positive and negative emotion to a mother who is sensitive and responsive to her child's emotional needs; an insecure child shows restricted communication towards a mother who rejects or dismisses her child (Bowlby, 1969). There is empirical evidence supporting these assumptions. For example, Isabella and Belsky's (1991) study revealed that mother-child dyads with a child whose behavior was later classified as secure were characterized by disproportionate synchronous interactions (reciprocal and mutually rewarding behavior). Mother-child dyads with a child whose behavior was later classified as insecure, were characterized disproportionate asynchronous interactions (unresponsive or intrusive behavioral exchange). Similar findings are reported by Crugnola et al. (2013) who examined how maternal representation of attachment influenced mother-infant emotion co-regulation. They found that mother-child dyads of mothers whose representations were classified as secure spent more time in matched states, but mother-child dyads of mothers whose representations were classified as insecure spent more time in mismatched states. Moreover, secure dyads were discovered to be more likely to be in shared positive states; in contrast, insecure dyads tended to spend more time in mutually negative states.

Based on prior evidence, three hypotheses were developed for this study:

1. Emotion co-regulation will differ between secure dyads and insecure dyads at both the pre-separation play episode and the final reunion. In both episodes the secure dyads will have higher flexibility and stay longer in dyadic positive affect and shorter in dyadic negative affect than insecure dyads.

2. Change in emotion co-regulation from the pre-separation play episode to the final reunion will be different for secure and insecure dyads. Secure dyads will show higher flexibility while insecure dyads will have more rigidity; both secure and insecure dyads will stay for shorter periods in dyadic positive affect and longer in dyadic negative affect during the final reunion.

3. The magnitude of change in emotion co-regulation from the pre-separation play episode to the final reunion will be different for secure dyads compared to insecure dyads. The magnitude of change in emotion co-regulation from the pre-separation play episode to the final reunion will be greater in the insecure dyads compared to the secure dyads.

Method

Participants

Subjects were participants from one of 10 sites at which the parent study, the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development (NICHD SECCYD), was undertaken. In the original study, mothers with healthy newborns were recruited from local hospitals throughout 1991. The investigators received the University Institutional Review Board (IRB) approval to view videotaped Strange Situation episodes for participants from their own site. The assessments at both 15 and 36 months had been previously classified. At 36 months there were 124 children who engaged in the Strange Situation. Forty-three were classified as insecure, and 81 were classified as secure. All 43 children with insecure classifications were selected for the study. Because instability in attachment security is relatively common (25% – 70%) and associated with more family risk than attachment stability over time (Vondra, Shaw, Swearingen, Cohen & Owens, 2001), we selected those cases with secure classifications at both 15 and 36 months to maximize differences between the two comparison groups. Four dyads who did not speak English during the Strange Situation were excluded. Ultimately, 80 dyads met criteria for the study with $n = 40$ secure and $n = 40$ insecure.

Procedure

Demographic data and Strange Situation data were collected in the original study (NICHD SECCYD). A modified Strange Situation was implemented in a playroom visit at 36 months of age. The emotion co-regulation data at 36 months were generated by coding affect expressions separately for the child and the mother every two seconds during the pre-separation play episode and the final reunion. By the final reunion the child's attachment system is highly activated. We coded only the final reunion because, by coding convention, the final reunion has the most weight in determining the child's attachment classification.

Mangold International's (2007) INTERACT 9.07 software was used to record the affect observations for each interval in real time. The coded observation data were then exported to GridWare 1.1, a SSG software program developed specially for the dynamic systems method and used to obtain indicators of emotion co-regulation: content-free emotion co-regulation (transition and dispersion), and content-specific emotion co-regulation (percent time in the positive region, and percent time in the negative region) (Lamey et al., 2004).

Measures

The Strange Situation—In the original study, a modified Strange Situation procedure was used to classify child attachment behavior at 36 months of age (see NICHD ECCRN, 2001 for details). The Strange Situation consisted of a series of three-minute episodes, any one of which was immediately curtailed if the child showed distress or if the parent so wished. These episodes consisted of (a) the pre-separation play, (b) the first separation, (c) the first reunion, (d) the second separation, and (e) the final reunion. Attachment security as a binary variable was coded in the original study (NICHD SECCYD) by coders certified by L. A. Sroufe. Affect was coded separately for the child and the mother during the pre-separation play and the final reunion episodes of the Strange Situation.

Affect coding—Affect codes were based on facial expression and verbal tone displayed by participants. The face validity of the affect codes was determined by having experts in the field read the manual and reach consensus on coding rules and definitions. There were five codes used for both mother and child (high positive affect, low positive affect, neutral affect, low negative affect, and high negative affect). High positive affect referred to moderate or strong enjoyment, happiness, excitement, or affection; low positive affect referred to subtle positive emotion conveying interest and validation; neutral affect referred to the absence of any positive or negative affect; low negative affect referred to subtle distress; and high negative affect referred to moderate or strong fear, sadness, anger, disgust, and contempt. For example, mother high positive affect included smile, laughter, empathetic look, and cheerleading or affectionate tone; mother low positive affect included subtle or fleeting smile, and interest or warm tone; mother low negative affect included frowning, lip compression, biting lip, and sighing; and mother high negative affect included irritable, impatient, threatening, and sarcastic tone, yelling, and eye rolling. Child positive and negative affect were indicated by similar developmentally relevant behavioral cues such as crying, fussing, whimpering, grunting sounds, whispering, giggling, and playful sounds.

The lead investigator tested and finalized the affect coding manual by self-training to reach test-retest reliability of *kappa* = .80. The lead investigator subsequently trained two undergraduate coders to reach 70% agreement with the lead investigator on three test cases. Both the coders and the lead investigator were blind to subjects' attachment classifications. Child and mother affect was then coded independently by the two trained coders. Reliability was established between the coder and lead investigator in all 80 videos. Inter-coder agreement for child and mother affect codes was 79% and 86%, respectively. Disagreements among coders were resolved by discussing discrepancies and reaching consensus for all 80 dyads.

State Space Grids—The coded observation data for the two Strange Situation episodes for each dyad were imported into GridWare 1.1 to construct the SSGs (Lamey et al., 2004). The five mother and child affect states were displayed on the grid's y-axis and x-axis, respectively. The five affect codes for each member of the dyad created a five-by-five matrix. Each of the 25 cells on the grid represented a possible dyadic emotional state. SSG captures both content-free and content-specific changes in dyadic interaction. The content-free emotion co-regulation reflects how the mother and child dyad regulate each other. The content-specific emotion co-regulation summarizes the shared emotional states characteristic of the dyad.

Transition and dispersion, indicators of content-free emotion co-regulation, were derived from GridWare 1.1 (Lamey et al., 2004). *Transition* is an indicator of the ability to shift among shared emotion states. A transition is equal to the number of cell visits minus one. A visit refers to one or more consequent events appearing within a single cell, beginning with the trajectory entering into the cell and ending with the trajectory leaving the cell. A higher number of transitions (more frequent changes in dyadic emotional states) indicates flexibility. *Dispersion* is an index of the distribution of emotional states. It was calculated as the sum of squared proportional durations across all cells, adjusted for the total number of cells in the grid, and inverted so that values ranged from zero to one. A higher dispersion

(more evenly distributed emotion across the grid of possible emotional states) indicates flexibility (Granic et al., 2007; Hollenstein et al., 2006; Lunkenheimer et al., 2011; Lunkenheimer et al., 2013).

Two regions of interest in SSGs were identified as indicators of content-specific emotion co-regulation (see Figure 1). The *positive region* describes dyadic positive affect sharing from neutral through high positive affect. The *negative region* refers to dyadic negative affect, in which either the mother or child (or both) expressed high negative affect. Possible dyadic patterns included mutual hostility (both the mother and child expressed negative affect); mother attack (the mother expressed negative affect when the child displayed low or high positive); or permissiveness (the mother showed neutral, low, or high positive affect while the child exhibited high negative affect) (Granic et al., 2007). Low negative affect (indicated by subtle distress) was not included in the negative region because the focus of this study was to examine how a mother and child regulate potent negative cues in the Strange Situation. Moreover, high and low negative affect were not significantly correlated, indicating that they were different emotional responses to stress. *Percent of time* in a region was operationalized as the total duration in the specific region divided by the total duration of the two Strange Situation episodes. The "total duration in each region" is an SSG variable generated by GridWare 1.1.

Statistical Analysis

The indicators of emotion co-regulation included transition, dispersion, percent time in the positive region, and percent time in the negative region. To examine the difference in the emotion co-regulation between the two groups (secure and insecure) and across two episodes (pre-separation play episode and final reunion), a linear mixed model (LMM) was applied and the main factors (group and time) and the interaction (group x time) were included in the model. The variance-covariance matrix between observations from the same dyads was constructed using compound symmetry structure in the LMM. The *post hoc* comparisons, including group difference at both time points, time difference in both groups, and group difference in change from the pre-separation to the final reunion, were performed for outcomes with significant main or interaction effects. The *post hoc* comparisons were adjusted using Bonferroni's method and adjusted *p*-values (*adj. p*) were presented. In addition, the baseline characteristics were examined between the two study groups using 2-sample t-tests for continuous variable and chi-square tests for categorical variables. The significance level was set at .05. All mixed model analysis was performed using SAS 9.4 (Cary, North Carolina) and baseline characteristics were evaluated using SPSS 22.0 (New York, IBM Corp).

Results

Sample Characteristics

Table 1 shows the demographic characteristics of the full sample and the secure and insecure subgroups. Maternal education and 36-month income-to-needs ratio were higher for the secure group; more secure-group children's fathers lived with them than was the case for the insecure-group children.

Content-Free and Content-Specific Emotion Co-Regulation

Table 2 shows that no significant difference was found in content-free emotion co-regulation (transition and dispersion) between time points or between study groups, which was contrary to our hypotheses. As to content specific emotion co-regulation (percent of time in the positive region and percent of time in the negative region), there was a significant group difference ($p < .001$), a significant time difference ($p < .001$), and a significant interaction between group and time ($p < .001$), as hypothesized. The *post hoc* comparisons revealed that the percent of time in the positive region during the final reunion was significantly longer for the secure group than for the insecure group (*adj. p* < .001). Such group differences were not significant during the pre-separation play episode (*adj. p* = .36); the insecure group spent significantly less time in the positive region during the final reunion than during the pre-separation play episode (*adj. p* < .001). Figure 2 graphically depicts the group by time interaction for percent of time in the positive and negative regions. Decreased time in the positive region across the two episodes was only marginally significant for the secure group (*adj. p* = .052). Within-group change in the positive region across the two episodes was significantly less in the secure group than in the insecure group (*adj. p* = .017). For the negative region, the *post hoc* comparisons showed that the percent of time in the negative region during the final reunion was significantly less for the secure group than the insecure group (*adj. p* < .001); but the difference was not significant for the pre-separation play episode (*adj. p* = 0.99). Both the insecure group (*adj. p* < .001) and the secure group (*adj. p* < .001) spent significantly more time in the negative region during the final reunion than during the pre-separation play episode; and the increase in percent time in the negative region between the two episodes was significantly less for the secure group (*adj. p* = .001).

Discussion

The purpose of the present study was to describe how emotion co-regulation varied within and between secure and insecure mother-child dyads in response to separation in the Strange Situation, using State Space Grids. The findings support the hypotheses that there were differences in content-specific emotion co-regulation between the pre-separation play and the final reunion episodes of the Strange Situation, and between the secure and insecure groups. Specifically, the secure and insecure dyads displayed significant differences in dyadic positive and negative affect only during the final reunion; the change in dyadic positive and negative affect from the pre-separation play episode to final reunion was observed to be significant in both the insecure and secure dyads; but the change was significantly greater in the insecure dyads. An examination of variable distributions revealed that all indicators of emotion co-regulation except transition were skewed; specifically, dispersion and percent of time in the positive region were negatively skewed and percent of time in the negative region was positively skewed. We also examined the distribution of the residuals from the LMM, where the skewness was improved but still not normally distributed. In order to avoid possible false claims of our findings, a bootstrapping method was also utilized using 1,000 bootstrap samples, and all the significant findings were confirmed.

As expected, during the final reunion secure dyads spent less time in dyadic negative affect and more time in dyadic positive affect than did the insecure dyads. This result confirmed prior findings that securely attached children are found to display more positive affect (e.g., Kerns, Abraham, Schlegemilch, & Morgan, 2007), and less negative affect (e.g., Shiller, Izard, & Hembree, 1986). Unexpectedly, there were no differences in time spent in dyadic positive and negative affect during the pre-separation play episode. The lack of difference during this less-stressful episode illustrates the importance of considering contextual factors when comparing dyadic affect between secure and insecure groups. This finding was not consistent with the study by Waters et al. (1979), in which 18-month-old infants with secure attachment classifications showed greater positive affect sharing with mothers during the pre-separation episode of the Strange Situation compared to insecure infants with either avoidant or resistant attachment classifications. The discrepancy in the findings of the two studies may be partially due to different methodologies (presence or absence of child's positive affect sharing behavior at any time during the pre-separation episode regardless of frequency in the Waters study vs. percent of time in dyadic positive emotional states in the pre-separation play episode in the present study). It could also be due to the difference in the ages of the children in the two studies, in which the older children in our study were either less stressed in the pre-separation episode than the younger children in the Waters et al. study, or gave more limited displays of distress (Izard & Abe, 2004).

As expected, a within group difference in content-specific emotion co-regulation across two episodes was revealed; secure and insecure dyads spent less time in dyadic positive affect and more time in dyadic negative affect during the final reunion than they did during the pre-separation play episode. After Bonferroni's correction, which is a relatively conservative approach, all within-group changes across the two episodes remained significant or marginally significant. The change in dyadic positive and negative affect was in the same direction for both secure and insecure, supporting theoretical speculation that successful emotion regulation requires the ability to adapt one's positive and negative affect appropriately to situations (Cole, Michel, & Teti, 1994). Unique to the present study, we revealed differences between secure and insecure dyads with the dyadic positive affect decreasing and dyadic negative increasing more dramatically in the insecure dyads than it did in the secure dyads. The smaller change in both positive and negative emotion display by secure dyads after the separation may reflect their greater ability to regulate strong emotions following a stressor.

Unexpectedly, content-free emotion co-regulation did not differ significantly between the two Strange Situation episodes or between the secure and insecure groups. Secure dyads did not show higher flexibility, nor insecure dyads more rigidity, during the final reunion; and secure dyads were not observed to have higher flexibility than insecure dyads. According to Bowlby's (1969) attachment theory, secure children should show negative emotion during separation and be soothed easily by sensitive and responsive mothers upon their return, such that they soon resume play. They are proposed to recover faster from a negative state compared to insecure dyads. In contrast, insecure children are thought to respond to stressful events by either persistently inhibiting or excessively expressing negative emotion in order to obtain nurturance from typically emotionally unresponsive or unavailable mothers.

Thus, the finding of no differences in flexibility was not in line with theoretical assumptions or consistent with the results for content-specific emotion regulation. Two factors may help explain these results: a developmental perspective on emotion co-regulation and the situational context of the dyadic interaction. Regarding the former, in a recent study in which SSGs were used to compare dyadic free-play patterns between secure and insecure dyads, Cerezo and his colleagues (2012) showed that at six months, secure dyads displayed higher flexibility compared to insecure dyads. However, this difference was not evident in dyads at 12 months. Izard and Abe (2004) found developmental changes in emotion expressions during the separations of the Strange Situation at 13 and 18 months (a significant increase in simpler patterns of emotional expression and a decrease in complex whole-face displays of emotion). The results of these two studies indicate the importance of studying developmental change of dyadic emotion regulation with a longitudinal design, using measures sensitive to children's growing capacity for emotion regulation.

Regarding situational contextual factors, Roque et al. (2013) showed that both secure and insecure children used more behavioral strategies (e.g., distraction, self-soothing, information seeking) during contexts intended to elicit frustration/anger or positive affect, than during contexts intended to elicit fear. Hollenstein and Lewis (2006) used SSGs to describe emotional expression by mother-adolescent daughter dyads during semi-structured interactions containing a positive task, a conflict task, and another positive task. They found that interpersonal flexibility was lowest during the conflict task episode. Roque et al.'s (2013) and Hollenstein and Lewis' (2006) studies suggest that content-free emotion co-regulation varies according to context. Future studies should compare the flexibility of secure and insecure dyads in different contexts (e.g., the Strange Situation vs. other situations).

Implications

This study described dyadic changes in co-occurring positive and negative affect during mother-child interaction in two episodes of the Strange Situation, using SSG methodology. The study's findings have both theoretical and clinical implications. The most pronounced difference between secure and insecure groups was in the magnitude of change in expressions of positive and negative emotion during the recovery to the separation stress in the final reunion episode. This empirical evidence from a dynamic systems perspective supports the attachment theory concept of the internal working model (IWM). The IWM is a regulatory system or strategy, organizing emotional and behavioral responses (Bretherton & Munholland, 1999). Specifically, a secure dyad's representation of a responsive attachment figure permits the expression of both positive and negative emotions openly and freely, during and after a stressful experience. In contrast, an insecure dyad's representation requires inhibiting or exaggerating negative emotions in order to maximize nurturance from a rejecting or inconsistently available attachment figure. Although the strategies of insecure dyads are adapted to their particular attachment relationship, these strategies may be maladaptive when applied by the child in other contexts or other relationships.

Dynamic systems theory and the SSG method would be useful for researchers who examine change processes following an intervention. Although there are successful evidence-based

interventions to promote parent-child relationships (e.g., Webster-Stratton, Reid, & Hammond, 2004), study methodologies designed to investigate the mechanism of dyadic change are lacking (Hinshaw, 2002; Kazdin, 2001). For example, O'Connor et al. (2013) designed a program to improve parent-child relationships for families with young children. In that program, parenting behavior (child-centered parenting, child-directive parenting, sensitive responding and mutuality) was coded during three tasks (free play, challenge task, and tidy up) and children's attachment narratives were assessed. The results showed that while there were increases in child-centered parenting behavior, there were no changes in child-directive parenting behavior, mutuality, or children's attachment narratives. For programs that investigate outcomes in terms of dyadic interaction, the SSG method may be helpful in detecting impact in certain areas of the parent-child relationship. Since this method looks beyond summary scores and temporal contingencies and captures changes in the dyad as a unit, it presents the opportunity to detect meaningful patterns in the context of second-to-second exchanges.

Limitations

There were four main limitations of this study. First, the source of the emotion co-regulation data was limited. Our emotion co-regulation data included only facial expression and verbal tone. Emotions expressed in body motion or behavioral strategies were not captured. Not all facial expression changes were observable due to camera angles. Moreover, physiological indicators of emotion regulation such as cardiac vagal tone and heart rate were not measured (Braungart-Rieker, Garwood, Powers, & Wang, 2001; Calkins & Johnson, 1998; Spangler & Grossmann, 1993; Stansbury & Sigman, 2000). Given that emotion regulation is reflected within the behavioral, affective, and physiological domains, the collection of emotion regulation indicators across multiple domains would improve validity of the data. Additionally, it would be useful to investigate the interactive effects of multiple measurement domains of emotion regulation. Secondly, this study used a relatively small sample size, with a relatively limited number of participants in some insecure sub-categories: avoidant (5), ambivalent (19), controlling caregiving (3), controlling general (6), and insecure other (7). All insecure attachment types were therefore combined into one insecure group in the present study; comparison of emotion co-regulation among specific attachment groups was not possible. Third, the generalizability of results from the present study is limited because patterns of emotion co-regulation may vary across contexts, partners, and development. For example, children with avoidant attachment minimize negative affect in the Strange Situation, but they are more likely to express negative emotion while interacting with peers in the parental absence (Berlin & Cassidy, 1999; Malatesta, Culver, Tesman, & Shepard, 1989). Finally, this study was conducted on a local, relatively low-risk, and primarily Caucasian population. The homogeneity of the population and small sample size limits the generalizability of the study's findings.

In summary, the unique contribution of the present study is its addition of data relevant to understanding mechanisms of emotion co-regulation in parent-child dyads, using a dynamic systems perspective on moment-to-moment change. The strength of the study is in its application of the SSG approach to operationalizing emotion co-regulation, and in the context of a well-established laboratory paradigm for parent-child interactions (i.e., the

Strange Situation). By exploring the multidimensionality of emotion regulation, the present study also expands the more limited focus of earlier research, which typically examined only the intensity of negative or positive affect in mother and child interaction. Future studies will need to explore emotion co-regulation within an expanded variety of dyads, including dyads of mothers and children in different social or stressful contexts, dyads of fathers and children, dyads of children and their peers, dyads from high-risk populations, and dyads from more diverse cultural backgrounds.

Acknowledgments

References

Ainsworth, MDS.; Blehar, M.; Waters, E.; Wall, S. Pattern of attachment: A psychological study of the Strange Situation. Hillsdale, NJ: Lawrence Erlbaum Associates; 1978.

Ashiabi GS. Promoting the emotional development of preschoolers. Early Childhood Education Journal. 2000; 28:79–84.

Barnard, KE. NCAST II learns resource manual. Seattle: NCAST Publications; 1976. Out of Print

Berlin, LJ.; Cassidy, J. Relations among relationships: Contributions from attachment theory and research. In: Cassidy, J.; Shaver, P., editors. Handbook of Attachment. New York: Guilford Press; 1999. p. 688-712.

Bowlby, J. Attachment and loss. Vol. 1. New York: Basic Books, INC; 1969.

Braungart-Rieker JM, Garwood MM, Powers BP, Wang X. Parental sensitivity, infant affect, and affect regulation: Predictors of later attachment. Child Development. 2001; 72(1):252–270. [PubMed: 11280483]

Bretherton I. Learning to talk about emotions: A functionalist perspective. Child Development. 1986; 55:529–548.

Bretherton, I.; Munholland, KA. Internal working models in attachment relationships: A construct revisited. In: Cassidy, J.; Shaver, P., editors. Handbook of Attachment. New York: Guilford Press; 1999. p. 89-111.

Bridges LJ, Denham SA, Ganiban JM. Definitional issues in emotion regulation research. Child Development. 2004; 75(2):340–345. [PubMed: 15056188]

Calkins SD. Origins and outcomes of individual differences in emotion regulation. The Development of Emotion Regulation: Biological and Behavioral Considerations Monographs of the Society for Research in Child Development. 1994; 59(2–3):53–72.

Calkins SD, Johnson MC. Toddler regulation of distress to frustrating events: Temperamental and maternal correlates. Infant Behavior and Development. 1998; 21(3):379–395.

Cassidy J. Emotion regulation: Influences of attachment relationships. Monographs of the Society for Research in Child Development. 1994; 59(2–3):228–283. [PubMed: 7984163]

Cerezo MA, Trenado RM, Pons-Salvador G. Mother-infant interaction and quality of child's attachment: a nonlinear dynamical systems approach. Nonlinear Dynamics, Psychology, and Life Sciences. 2012; 16(3):243–267.

Cole PM, Michel MK, Teti LO. The development of emotion regulation and dysregulation: A clinical perspective. Monographs of the Society for Research in Child Development. 1994; 59:73–100. [PubMed: 7984169]

Cole PM, Teti LO, Zahn-Waxler C. Mutual emotion regulation and the stability of conduct problems between preschool and early school age. Development and Psychopathology. 2003; 15(1):1–18. [PubMed: 12848432]

Connell JP, Thompson R. Emotion and social interaction in the strange situation: Consistencies and asymmetric influences in the second year. Child Development. 1986; 57(3):733–745. http://dx.doi.org/10.2307/1130350.

Crugnola CR, Gazzotti S, Spinelli M, Ierardi E, Caprin C, Albizzati A. Maternal attachment influences mother–infant styles of regulation and play with objects at nine months. Attachment & Human Development. 2013; 15(2):107–131.10.1080/14616734.2013.745712 [PubMed: 23228174]

Deater-Deckard K, Atzaba-Poria N, Pike A. Mother- and father-child mutuality in Anglo and Indian British families: a link with lower externalizing problems. Journal of Abnormal Child Psychology. 2004; 32(6):609–620. [PubMed: 15648528]

Deater-Deckard K, Petrill SA. Parent-child dyadic mutuality and child behavior problems: An investigation of gene-environment processes. Journal of Child Psychology and Psychiatry. 2004; 45(6):1171–1179. http://dx.doi.org/10.1111/j.1469-7610.2004.00309.x. [PubMed: 15257673]

Denham, SS. Emotional development in young children. New York: Guilford; 1998.

Diamond LM, Aspinwall L. Emotion regulation across life span: An integrative perspective emphasizing self-regulation, positive affect, and dyadic processes. Motivation and Emotion. 2003; 27(2):125–177.

DiDonato MD, England D, Martin CL, Amazeen PG. Dynamical analyses for developmental science: A primer for intrigued scientists. Human Development. 2013; 56:59–75.

Dishion TJ, Nelson SE, Winter CE, Bullock BM. Adolescent friendship as a dynamic system: Entropy and deviance in the etiology and course of male antisocial behavior. Journal of Abnormal Child Psychology. 2004; 32(6):651–663. http://dx.doi.org/10.1023/B:JACP.0000047213.31812.21. [PubMed: 15648531]

Dumas JE, LaFreniere PJ, Serketich WJ. "Balance of power": A transactional analysis of control in mother-child dyads involving socially competent, aggressive, and anxious children. Journal of Abnormal Psychology. 1995; 104(1):104–113. http://dx.doi.org/10.1037/0021-843X.104.1.104. [PubMed: 7897032]

Eisenberg N, Spinrad TL. Emotion-related regulation: Sharpening the definition. Child Development. 2004; 75(2):334–339. [PubMed: 15056187]

Eisenberg N, Spinrad TL, Eggum ND. Emotion-related self-regulation and its relation to children's maladjustment. The annual Review of Clinical Psychology. 2010; 6:495–525.

Etzion-Carasso A, Oppenheim D. Open mother-preschooler communication: Relations with early secure attachment. Attachment & Human Development. 2000; 2:347–370. [PubMed: 11708223]

Feldman R. Infant-mother and infant-father synchrony: The coregulation of positive arousal. Infant Mental Health Journal. 2003; 24:1–23.

Fogel A. Theoretical and applied dynamic systems research in developmental science. Child Development Perspectives. 2011; 5(4):267–272.

Fox NA. Temperament and regulation of emotion in the first years of life. Pediatrics. 1998; 102:1230–1235. [PubMed: 9794960]

Gottman JM, Katz LF, Hooven C. Parental meta-emotion philosophy and the emotional life of families: Theoretical models and preliminary data. Journal of Family Psychology. 1996; 10(3):243–268. http://dx.doi.org/10.1037/0893-3200.10.3.243.

Granic I, O'Hara A, Pepler D, Lewis M. A dynamic systems analysis of parent-child changes associated with successful "real-world" interventions for aggressive children. Journal of Abnormal Child Psychology. 2007; 35(5):845–857. [PubMed: 17549621]

Granic I, Patterson GR. Toward a comprehensive model of antisocial development: A dynamic systems approach. Psychological Review. 2006; 113:101–131. [PubMed: 16478303]

Gross JJ. The emerging field of emotion regulation: An integrative review. Review of General Psychology. 1998; 2(3):271–299.

Hinshaw SP. Intervention research, theoretical mechanisms and causal processes related to externalizing behavior patterns. Development and Psychopathology. 2002; 14:789–818. [PubMed: 12549704]

Hollenstein T. Twenty years of dynamic systems approaches to development: Significant contributions, challenges, and future directions. Child Development Perspectives. 2011; 5(4):256–259.

Hollenstein T, Granic I, Stoolmiller M, Snyder J. Rigidity in parent-child interactions and the development of externalizing and internalizing behavior in early childhood. Journal of Abnormal Child Psychology. 2004; 32(6):595–607. [PubMed: 15648527]

Hollenstein T, Lewis MD. A state space analysis of emotion and flexibility in parent-child interactions. Emotion. 2006; 6(4):656–662. [PubMed: 17144756]

Isabella RA, Belsky J. Interactional synchrony and the origins of infant-mother attachment: A replication study. Child Development. 1991; 62(2):373.10.1111/1467-8624.ep9104222727 [PubMed: 2055128]

Izard CE, Abe JAA. Developmental changes in facial expressions of emotions in the strange situation during the second year of life. Emotion. 2004; 4(3):251–265. http://dx.doi.org/10.1037/1528-3542.4.3.251. [PubMed: 15456394]

Kazdin AE. Progression of therapy research and clinical application of treatment require better understanding of the change process. Clinical Psychology: Science and Practice: Special Issue. 2001; 8:143–151.

Kerns KA, Abraham MM, Schlegemilch A, Morgan TA. Mother-child attachment in later childhood: Assessment approaches and associates with mood and emotion regulation. Attachment & Human Development. 2007; 9(1):33–53. [PubMed: 17364481]

Kochanska G. Emotional development in children with different attachment histories: The first three years. Child Development. 2001; 72:474–490. [PubMed: 11333079]

Kochanska G, Coy KC, Murray KT. The development of self-regulation in the first four years of life. Child Development. 2001; 72(4):1091–1111. [PubMed: 11480936]

Kopp CB. Regulation of distress and negative emotions: A developmental view. Developmental Psychology. 1989; 25(3):343–354.

Lamey, A.; Hollenstein, T.; Lewis, MD.; Granic, I. GridWare (Version 1.1). 2004. Computer software Retrieved from http://www.statespacegrids.org

Lavelli M, Fogel A. Developmental changes in the relationship between infant attention and emotion during early face-to-face communication: The 2-month transition. Developmental Psychology. 2005; 41:265–280. [PubMed: 15656754]

Lewis MD. Dynamic systems approaches: Cool enough? Hot enough? Child Development Perspectives. 2011; 5(4):279–285.

Lunkenheimer ES, Albrecht EC, Kemp CJ. Dyadic flexibility in early parent- child interactions: Relations with maternal depressive symptoms and child negativity and behaviour problems. Infant and Child Development. 2013; 22(3):250–269. http://dx.doi.org/10.1002/icd.1783. [PubMed: 24027424]

Lunkenheimer ES, Hollenstein T, Wang J, Shields AM. Flexibility and attractors in context: family emotion socialization patterns and children's emotion regulation in late childhood. Nonlinear Dynamics, Psychology, and Life Sciences. 2012; 16(3):269–291.

Lunkenheimer ES, Olson SL, Hollenstein T, Sameroff AJ, Winter C. Dyadic flexibility and positive affect in parent-child coregulation and the development of child behavior problems. Development and Psychopathology. 2011; 23(2):577–591. [PubMed: 23786697]

Main, M.; Kaplan, N.; Cassidy, J. Security in infancy, childhood, and adulthood: A move to the level of representation. In: Bretherton, I.; Waters, E., editors. Growing points in attachment theory and research. Monographs of the Society for Research in Child Development. Vol. 50. 1985. p. 66-106.

Matas L, Arend RA, Sroufe LA. Continuity of adaptation in the second year: The relationship between quality of attachment and later competence. Child Development. 1978; 49:547–556.

Malatesta CZ, Culver C, Tesman JR, Shepard B. The development of emotion expression during the first two years of emotion expression during the first two years of life. Monograph of the Society for Research in Child Development. 1989; 54(1–2) Serial NO. 219.

Mangold, P. INTERACT (Version 9.07) [Computer software]. Arnstorf, Germany: Mangold International GmbH; 2007.

Mikulincer M, Shaver PR, Pereg D. Attachment theory and affect regulation: The dynamics, development, and cognitive consequences of attachment-related strategies. Motivation and Emotion. 2003; 27(2):77–102.

NICHD Early Child Care Research Network. Child care and family predictors of preschool attachment and stability from infancy. Developmental Psychology. 2001; 37(6):847–862. [PubMed: 11699758]

NICHD Early Child Care Research Network. Affect dysregulation in the mother-child relationship in the toddler years: Antecedents and consequences. Development and Psychopathology. 2004; 16(1):43–68. [PubMed: 15115064]

O'Connor T, Matias C, Futh A, Tantam G, Scott S. Social learning theory parenting intervention promotes attachment-based caregiving in young children: Randomized clinical trial. Journal of Clinical Child & Adolescent Psychology. 2013; 42(3):358–370. [PubMed: 23020146]

Patterson, GR. Coercive family processes. Eugene, OR: Castalia; 1982.

Pastor DL. The quality of mother-infant attachment and its relationship to toddlers' initial sociality with peers. Developmental Psychology. 1981; 17:326–335.

Ridgeway D, Waters E, Kuczaj SA II. Acquisition of emotion-descriptive language: Receptive and productive vocabulary norms for ages 18 months to 6 years. Developmental Psychology. 1985; 21:901–908.

Roque L, Veríssimo M, Fernandes M, Rebelo A. Emotion regulation and attachment: relationships with children's secure base, during different situational and social contexts in naturalistic settings. Infant Behavior & Development. 2013; 36(3):298–306.10.1016/j.infbeh.2013.03.003 [PubMed: 23542812]

Shiller VM, Lizard CE, Hembree EA. Patterns of Emotion Expression During Separation in the Strange-Situation Procedure. Developmental Psychology. 1986; 22(3):378–382.

Spangler G, Grossmann KE. Biobehavioral organization in securely and insecurely attached infants. Child Development. 1993; 64:1439–1450. [PubMed: 8222882]

Sravish AV, Tronick E, Hollenstein T, Beeghly M. Dyadic flexibility during the face-to-face Still-Face paradigm: A dynamic systems analysis of its temporal organization. Infant Behavior & Development. 2013; 36(3):432–437. [PubMed: 23639334]

Sroufe, LA. Emotional development: The organization of emotional life in the early years. New York, NY: Cambridge University Press; 1996.

Sroufe LA. Attachment and development: A prospective, longitudinal study from birth to adulthood. Attachment & Human Development. 2005; 7(4):349–367. [PubMed: 16332580]

Stansbury K, Sigman M. Responses of preschoolers in two frustrating episodes: Emergence of complex strategies: Emergence of complex strategies for emotion regulation. The Journal of Genetic Psychology. 2000; 161(2):182–202. [PubMed: 10851681]

Stern, DN. The interpersonal world of the infant. New York: Basic Books; 1985.

Thompson RA. Emotion regulation: A theme in search of definition. The Development of Emotion Regulation: Biological and Behavioral Considerations Monographs of the Society for Research in Child Development. 1994; 59(2–3):25–52.

Tronick, E. The neurobehavioral and social-emotional development of infants and children. New York: W.W. Norton & Company, Inc; 2007.

Tronick EZ. Emotions and emotional communication in infants. American Psychologist. 1989; 44:112–119. [PubMed: 2653124]

Tronick E, Als H, Adamson L, Wise S, Brazelton TB. The infant's response to entrapment between contradictory messages in face-to-face interaction. Journal of the American Academy of Child & Adolescent Psychiatry. 1978; 17:1–13.

Tronick ED, Als H, Brazelton TB. Mutuality in mother-infant interaction. Journal of Communication. 1977; 27(2):74–79. [PubMed: 853138]

Tronick EZ, Cohn J. Infant-mother face-to-face interaction: Age and gender differences in coordination and the occurrence of miscoordination. Child Development. 1989; 60(1):85–92. [PubMed: 2702877]

Tronick, EZ.; Ricks, M.; Cohn, J. Maternal and infant affective exchanges: Patterns of adaptation. In: Field, T.; Fogel, A., editors. Emotion and interaction: Normal and high risk infants. Hillsdale, NJ: Lawrence Erlbaum Associates; 1982. p. 83-100.

Vondra JI, Shaw DS, Swearingen L, Cohen M, Owens EB. Attachment stability and emotional and behavioral regulation from infancy to preschool age. Development and Psychopathology. 2001; 13(1):13–33. [PubMed: 11346048]

Waters E, Wippman J, Sroufe LA. Attachment, positive affect, and competence in the peer group: Two studies in construct validation. Child Development. 1979; 50(3):821–829. [PubMed: 498856]

Webster-Stratton C, Reid MJ, Hammond M. Treating children with early-onset conduct problems: Intervention outcomes for parent, child and teacher training. Journal of Clinical Child and Adolescent Psychology. 2004; 33(1):105–124. [PubMed: 15028546]

Weinfield, NS.; Sroufe, LA.; Egeland, B. The nature of individual differences in infant-caregiver attachment. In: Cassidy, J.; Shaver, PR., editors. Handbook of attachment: Theory, research, and clinical applications. New York, NY: Guilford Press; 1999. p. 64-86.

Wilson S, Durbin CE. Mother-child and father-child dyadic interaction: Parental and child bids and responsiveness to each other during early childhood. Merrill-Palmer Quarterly. 2013; 59(3):249–279. http://dx.doi.org/10.1353/mpq.2013.0018.
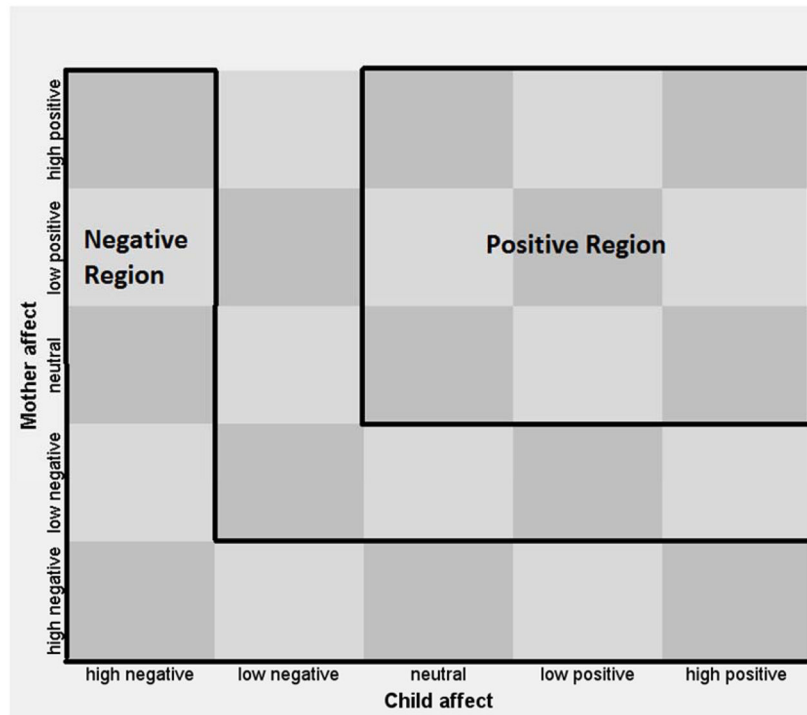
Figure 1.
Regions defined in State Space Grid.

Note. Positive region = dyadic positive affect sharing mutual neutral or positive affect; Negative region = dyadic negative affect, including mutual hostility (both the mother and child expressed negative affect), mother attack (the mother expressed negative affect when the child displayed low or high positive), and permissiveness (the mother showed neutral, low, or high positive affect while the child exhibited high negative affect)

Figure 2.
Interaction Effects of Positive and Negative Regions by Group and Time.
Note. Positive region = dyadic positive affect sharing mutual neutral or positive affect;
Negative region = dyadic negative affect, including mutual hostility (both the mother and
child expressed negative affect), mother attack (the mother expressed negative affect when
the child displayed low or high positive), and permissiveness (the mother showed neutral,
low, or high positive affect while the child exhibited high negative affect)
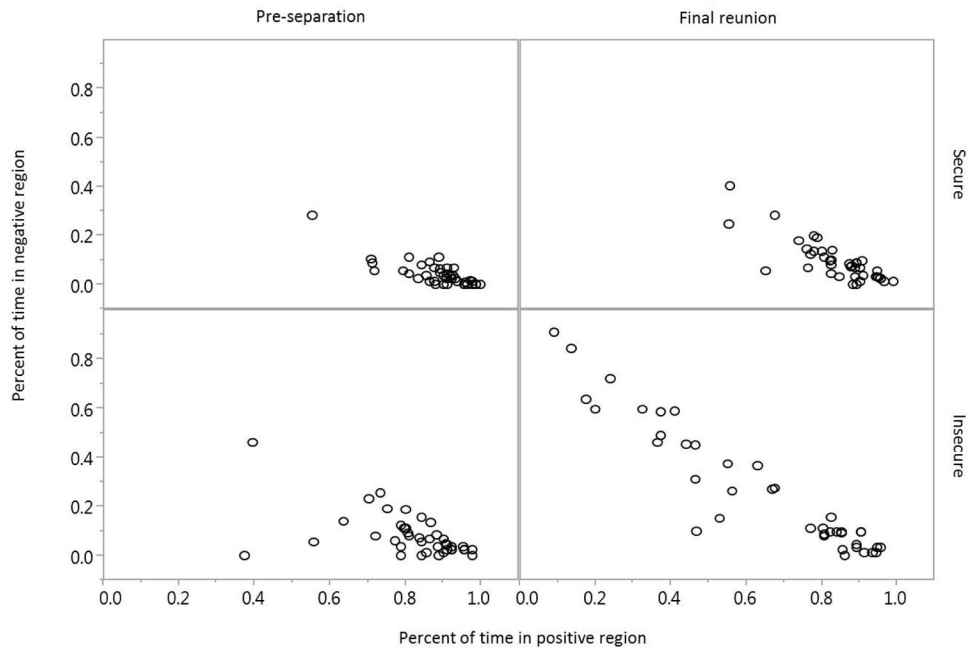
Table 1

Sample Demographic Characteristics

Characteristic	Full Sample (*N*=80)	Secure (*n*=40)	Insecure (*n*=40)	Test Statistics (t or χ^2)
	% (*n*) or M (SD)	**% (*n*) or M (SD)**	**% (*n*) or M (SD)**	
Child gender [a]				.80
Male	50% (*n*=40)	55% (*n*=22)	45% (*n*=18)	
Female	50% (*n*=40)	45% (*n*=18)	55% (*n*=22)	
Child ethnicity				3.12^
Caucasian	82.5% (*n*=66)	90% (*n*=36)	75% (*n*=30)	
Non- Caucasian	17.5% (*n*=14)	10% (*n*=4)	25% (*n*=10)	
Maternal age (years)	29.95 (5.30)	30.48 (5.06)	29.43 (5.53)	−.89
Maternal education (years)	15.01 (2.36)	15.63 (2.27)	14.40 (2.32)	−2.39*
Income-to-Needs ratio 36m	4.11 (3.50)	5.07 (4.10)	3.1 (2.45)	−2.54*
Father status 36m				4.59*
Living with father	77.5% (*n*=62)	87.5% (*n*=35)	67.5% (*n*=27)	
Not living with father	22.5% (*n*=18)	12.5% (*n*=5)	32.5% (*n*=13)	

Note:

[a] male = 0 and female = 1.

^
$p < 0.10$.

*
$p < 0.05$.

**
$p < 0.01$.

Table 2

Differences in Emotion Co-regulation Across Episodes and Between Groups

Time	Group	Mean	SD	Min	Q1	Median	Q3	Max
Transition								
Pre-separation (P1)	Secure	53.73	8.75	18.00	49	55	58.75	68.00
	Insecure	54.45	8.56	17.00	51.25	55.50	59.75	70.00
Final reunion (R2)	Secure	55.18	9.93	30.00	48.25	57.00	60.75	80.00
	Insecure	53.25	11.03	30.00	48.00	51.50	59.75	84.00
Change (R2-P1)	Secure	1.45	12.99	-26.0	-6.75	1.00	8.00	42.00
	Insecure	-1.20	11.82	-27.00	-9.75	-1.50	7.00	27.00
Dispersion								
Pre-separation (P1)	Secure	.87	.10	.30	.87	.89	.92	.94
	Insecure	.87	.07	.52	.86	.88	.91	.94
Final reunion (R2)	Secure	.87	.07	.61	.85	.88	.92	.95
	Insecure	.87	.06	.70	.84	.88	.92	.96
Change (R2-P1)	Secure	-.00	.12	-.26	-.06	-.01	.04	.57
	Insecure	-.00	.08	-.20	-.04	.00	.04	.20
Percent of time in positive region								
Pre-separation (P1)	Secure	88.62	9.07	55.31	85.87	90.61	95.11	100.0
	Insecure	82.0	13.55	37.43	78.83	84.44	90.98	97.77
Final reunion (R2)[1]	Secure	84.16	10.29	55.33	78.30	87.59	90.55	99.01
	Insecure	63.90	26.58	8.99	41.95	72.29	85.98	95.68
Change (R2-P1)[1]	Secure	-4.46	10.48	-40.20	-9.34	-2.82	2.07	12.26
	Insecure[2]	-18.06	25.90	-73.36	-35.52	-9.23	3.79	21.62
Percent of time in negative region								
Pre-separation (P1)	Secure	4.14	5.14	0.00	0.14	2.79	6.45	27.93
	Insecure	7.94	8.91	0.00	2.22	5.56	11.14	45.81
Final reunion (R2)[1]	Secure	9.11	8.28	0.00	3.22	7.29	13.02	40.00
	Insecure	26.77	25.68	0.00	8.07	12.95	45.75	91.01

Time	Group	Mean	SD	Min	Q1	Median	Q3	Max
Change (R2-P1)[1]	Secure[2]	4.97	7.30	-7.89	0.04	3.47	7.32	31.06
	Insecure[2]	18.83	25.93	-21.09	-1.35	10.76	36.26	85.48

Note. SD=standard deviation; Min=minimum; Q1= first quartile; Q3= third quartile; Max= maximum.

[1] Significant difference between secure and insecure groups based on the linear mixed model with multiple comparison adjustment.

[2] Significant change from the pre-separation play episode to final reunion based on the linear mixed model with multiple comparison adjustment.