Dynamics of Emotion Regulation in Infants of Clinically Depressed and Nondepressed Mothers

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Abstract

Background—Emotional regulation (ER) has been conceptualized as an ongoing process of the individual's emotion patterns in relation to moment-to-moment contextual demands. In contrast to traditional approaches of descriptively quantizing ER, we employed a dynamic approach to ER by examining key transitions in infants of clinically depressed and nondepressed mothers in the context of maternal still-face (SF).

Methods—Mothers with (*n*=48) and without a clinical diagnosis of depression (*n*=68) were seen in a modified SF paradigm with their 5-month-olds. Infant states and self-soothing behaviors were coded in 1-sec time intervals.

Results—Infants of nondepressed mothers used attentional regulatory strategies, whereas infants of depressed mothers used internally directed strategies of self-soothing to reduce negativity and maintain engagement with mother.

Conclusions—This study advances our understanding of processes underlying infant ER and points to possible mechanisms for the development of long-term maladaptive ER strategies in infants of depressed mothers.

The ability to regulate emotions is an important early developmental milestone with significant implications for many areas of development. Emotion regulation (ER) during infancy is partly dyadic because the caregiver is central to providing regulation that the child needs, which in turn facilitates development of autonomous child regulation. ER has been defined as attempts to modulate and to manage, through developmentally appropriate mechanisms, internal arousal in the face of heightened levels of emotions (Kopp, 1989). A particularly powerful setting to study early capacity for ER is the still-face paradigm (SFP; Tronick, Als, Adamson, Wise, & Brazelton, 1978), an experimental manipulation that inserts a period of adult unresponsiveness into a normal ongoing adult-infant social interaction. The procedure typically induces moderate negative arousal in infants (Moore et al., 2009) which offers a window on infants' emerging regulatory abilities. Because putative regulatory behaviors often accompany emotional arousal, and because we wished to study infants' self-initiated regulatory behaviors in the absence of maternal regulation, we

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examined the still-face episode of the SFP. During SF, infants typically show gaze aversion, self-soothing, and lowered positive and heightened negative affect (Weinberg, Beeghly, Olson, & Tronick, 2008). These affective and attentional behaviors have been interpreted as infants' attempts to regulate their negative arousal ("self-directed regulatory behaviors") and to re-establish reciprocal normal patterns of interaction ("other-directed regulatory behaviors"; Gianinio & Tronick, 1988).

To date, researchers have examined infant ER mainly by quantifying behaviors as some variant of the frequency or duration infants engage in them (e.g., Braungart-Rieker, Garwood, Powers, & Notaro, 1998; Mangelsdorf, Shapiro, & Marzolf, 1995). In the present study, we adopt an alternative dynamic approach to examine infant ER during a SFP. Although previous studies have used dynamic approaches such as time-domain analyses, they have primarily examined some form of mother-infant synchrony or co-regulation in the context of free play (Beebe et al., 2008; Feldman, 2003; Field et al., 1990). Here, we examine infant ER during negative arousal generated by a modified SFP (Cohn & Tronick, 1983), in the context of maternal unavailability, in typically developing infants and, as an informative comparison, infants being reared by clinically depressed mothers. We chose to use a modified SFP because it is more reflective of the maternal interactive behaviors of clinically depressed mothers compared to the traditional SFP.

A Dynamic Approach to Infant Emotion Regulation

Our dynamic approach is based on characterizing ER as an ongoing process of the individual's emotion patterns in relation to moment-to-moment contextual demands (Cole, Martin, & Dennis, 2004). In maternal SF, the mother is en face but is unresponsive. By withdrawing all forms to interaction, the mother no longer provides the infant with the regulatory support an infant often needs to maintain an organized social and affective state (Mayes & Carter, 1990). The infant has to "resolve" this sudden lack of responsiveness possibly by communicating the intolerance of the situation, regulating negative arousal, and eliciting expected reciprocal interaction. Thus, the regulatory tasks for the infant are to engage with the mother sufficiently to signal that mutual regulation should be re-established and then disengage enough to modulate negative arousal. Given that communicative and self-regulatory behaviors are concurrent and reciprocal, each affecting the success of the other (Gianino & Tronick, 1988), we reasoned that the dynamics of ER might be best captured by studying the sequential ordering of infant states that are indicative of self-regulation. To do this, we coded infant behaviors continuously and exhaustively and conducted sequential analyses of key transitions between selected behaviors. We present the rationales for selecting certain behaviors and transitions between them.

One of the ways emotions are regulated is by managing intake of emotionally arousing information through attention (Harman, Rothbart, & Posner, 1997). The ability to disengage from the source of distress is a key element of ER. Infants older than 3 months are able to disengage visually from emotionally arousing events such as episodes of mother-infant play (Gianino & Tronick, 1988). Gaze aversion reduces autonomic arousal (Field, 1981) and negative affect (Stifter & Braungart, 1995). In the context of the SFP, the most aversive experience for infants occurs when their attempts to reengage mothers' attention fail. When mothers do not respond to their infants' bid to restore the interaction, infants display frustration and high negative arousal. We hypothesized that infants with better regulatory skills will be able to disengage from the source of aversive experience and avert their gaze from mother. In this regard, Cohn and Tronick (1983) showed that when 3-month-olds became positive briefly, they transitioned to gaze avert. Thus, one transition indicative of infant ER that we examine is from social play with mother (i.e., attempting to reengage her socially) to gaze avert (SocPlay → GazeAvert).

Self-regulation is also studied in terms of expressions of affective state. If visual disengagement from the mother serves a regulatory function, then infants in a state of disengagement would not be expected to transition to a negative affective state. If the expression of distress remerges after a period of visual distraction (i.e., look at object), then the putative regulatory strategy has not altered the distress state, but merely accompanied arousal, and failed to serve a regulatory function (Buss & Goldsmith, 1998; Harman et al., 1997). On these grounds, we examine two additional transitions, from gaze avert to a negative state (GazeAvert → Negative) and from attending to objects to a negative state (ObjAttend→ Negative).

Infant affective displays communicate information about states and needs, signaling and directing the caregiver's behavior (Tronick, 1989). Externally directed regulatory capacities are those behaviors that infants use to engage the external world and elicit responses from adults, such as gaze and affective behaviors (Tronick & Gianino, 1986). Given the context of an unresponsive mother, "gaze following negative protest may function as a bid for help and comforting" (Mayes & Carter, 1990, p. 762). Thus, we also examine the transition (Negative → Monitor) from a negative state to gaze towards mother as a putative ER strategy.

In addition to these externally driven transitions, we examine the regulatory role of self-soothing. Self-soothing consists of internally directed behaviors that regulate tension and maintain engagement with the external environment (Tronick & Gianino, 1986). Thus, one transition we examine was from infant negative state to self-soothing (Negative → SSoothing). Given that visual engagement with the mother is highly arousing in the context of maternal SF, transitioning from this state to self-soothing could indicate regulation. Thus, we examine engagement with mother to self-soothing (EngM → SSoothing). Last, efficient self-soothing should result in the ability to reengage with the mother, and so we examine that transition (SSoothing → EngM).

Maternal Depression and Infant ER

Infants' experiences with caregivers are important determinants of their ER. One principal factor that interferes with mothers' ability to support their infants' acquisition of ER is depression. Because of her own emotional and cognitive state, the depressed mother is likely to be unresponsive to her infant's regulatory signals, and thus fails to provide her infant with appropriate and contingent stimulation to facilitate development of ER (Feldman, 2003). Studies have shown initial maternal depression to predict later ER difficulties in 4 year olds (Feng et al., 2008; Maughan et al., 2007). Beebe et al. (2008) found that during free-play, self-contingency, operationalized as auto-correlation, was lower in most modalities for infants of mothers who had previously reported higher depressive symptoms. Thus, to better understand the process of ER, we included infants of depressed mothers who would presumably show poorer regulation skills compared to infants of nondepressed mothers.

Previous studies have arrived at equivocal findings regarding differences in affective and regulatory behaviors during the SF between infants of depressed and nondepressed mothers. Infants of mothers with depressive symptomatology (Field, 1984) and dysthymic mothers (Field et al., 2007) versus infants of nondepressed mothers reportedly show less motor activity, distress behavior, and gaze aversion during SF. However, other studies show no relation between mothers' depressive symptomatology (Moore & Calkins, 2004) or clinical depression (Stanley, Murray & Stein, 2004) and infant regulation as evidenced by suppression of vagal tone or change in affective and attentional behaviors during the SFP. In addition, Moore, Cohn, and Campbell (2001) found no effect for chronicity of maternal depression on infant affective responses at 2, 4, or 6 months, although at 4 months more maternal depressive symptoms were associated with less infant gaze aversion.

We hypothesize that a dynamic behavior approach to studying infant ER between infants of clinically depressed and nondepressed mothers provides a more discerning view than the traditional approach of quantifying behaviors. We hypothesize that infants of clinically depressed mothers would not be as efficient or successful in ER as infants of nondepressed mothers during the SF. Hence, infants of depressed mothers would not be able to transition efficiently from social play with mother to gaze avert (SocPlay → GazeAvert). In addition, we hypothesize that the strategy of disengagement by averting gaze or attending to objects would be followed by negative arousal in infants of depressed mothers but not in infants of nondepressed mothers (GazeAvert → Negative and ObjAttend → Negative). We also hypothesize that the communicative role of negativity in infants, by transitioning from negative states to gazing at mother (Negative → Monitor), would not be observed in infants of depressed mothers. Last, we expect self-soothing behaviors to regulate negative arousal (Negative → SSoothing and EngM → SSoothing) and be followed by engagement with mother (SSoothing → EngM) only in infants of nondepressed mothers.

Methods

Participants and Selection Criteria

Mothers (≥ 20 years) were recruited through mass mailings, women's groups, and newspaper advertisements from the Washington DC metropolitan area. All infants were term, healthy, singletons with no known genetic disorders or birth complications. Between 4 and 20 weeks postpartum, the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996) was mailed to 536 mothers. Of 461 who returned the BDI, 308 with low (1–7) and high scores (> 12) were recruited to participate between 3 and 5 months in the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I; First, Spitzer, Gibbon, & Williams, 2001). At this interview, the definition of a "current" episode of depression was modified to "within the lifetime of the child" because that was the question of interest. Of those recruited, only 233 appeared for the interview. Mothers who did not interview (n=75) had significantly lower BDI scores (M=9.87, SD=9.03) than mothers who did (M=12.26, SD=9.94), $t(306) = 2.84$, $p < .01$. Mothers diagnosed as having had major or minor depression within the lifetime of the child were selected into the depressed group (n=78). Mothers not diagnosed with any depressive disorder from the low BDI group were selected into the nondepressed group (n=88). Mothers who either scored high on BDI but were not diagnosed with depressive disorders or low on BDI and diagnosed with non-depressive disorder (e.g., ADHD, Bipolar I) were not selected (n=67). Of those selected, 48 depressed (29 boys, 19 girls) and 70 nondepressed mothers (39 boys, 31 girls) completed the protocol. Mothers who did not (n=48) had older infants (M=14.71 weeks, SD=3.23) than mothers who did (M=13.80 weeks, SD=2.93); there were no significant differences in maternal age, education, parity, marital status, or BDI scores between the two groups.

Mothers' ages ranged from 21 to 43 years (M=32.03, SD=4.31); their infants ranged from 20 to 23 weeks ($M = 21.74$, $SD = 0.80$). The ethnic distribution included 68.1% non-Hispanic European American, 15.1% African American, 8.4% Latin American, 5.0% Asian American, and 3.3% mixed or other ethnicity. 20.2% of the mothers had partial college or less, 42.0% had completed college, and 37.8% had completed university graduate programs. The two groups of depressed and nondepressed mothers were comparable on all sociodemographic variables except education and firstborn status; 89% of nondepressed mothers vs. 67% of depressed mothers were college educated. Also 66% of infants in the nondepressed group vs. 46% in the depressed group were firstborns. Of the mothers in the depressed group, 9 (18.8%) had co-morbid Axis I disorders, primarily Generalized Anxiety Disorder (GAD); 15 (31.25%) were currently on medication.

Procedure

A modified SFP (Cohn & Tronick, 1983) was conducted in a laboratory setting. The infant was placed in an infant seat across from his/her mother at eye level with no toys. Three cameras were positioned to capture two different views of infant and one of the mother, and optimal camera shots of the infant were combined with one of the mother to generate split-screen records with digital time codes. The first SF episode was a 3-min naturalistic interaction (Baseline), during which mothers were asked to "play with your baby naturally, like you would at home." The second episode was a 2-min modified SF interaction, wherein mothers were asked to behave as they would on days when they felt tired and unable to play effectively with their infant; they were instructed to direct gaze toward their infant, speak in a flat uninteresting monotone, keep their faces expressionless, and minimize body movement and touch contact with their infant (see Cohn & Tronick, 1983). Before the start of the SFP, mothers observed a standard demonstration of how to behave. Last came a 2-min Recovery episode where the mother returned to natural play. Mothers were told that the procedure would be interrupted if the infant cried continuously for 15 sec. Two infants, both of nondepressed mothers, became upset during the SF and were omitted from the present analyses, resulting in *n*=68 for nondepressed mothers. Informed consent was obtained according to IRB procedures.

Data Coding

Infant behaviors were coded blind to participant diagnosis and to the hypotheses of the study. Infant affective states that were characterized as coherent configurations of facial expressions and behaviors were coded (see Weinberg & Tronick, 1996), rather than discrete behaviors. The coding system was based on Infant Regulatory Scoring System (IRSS; Tronick & Weinberg, 1990) and the AFFEX system (Izzard & Dougherty, 1980). Infant states were coded into mutually exclusive and exhaustive codes of gaze aversion (active gaze away from mother's face or objects with neutral or slightly negative facial expression), negative (facial expression, vocalization), wary (gaze at mother, serious-sober facial expression with eyebrows narrowed), monitor (gaze at mother's face with neutral expression or vocalization), object attend (focused attention on objects in the SFP setting), and social play (gaze at mother's face with positive expression or vocalization). Engagement with the mother was a composite of social play and monitor. Self-soothing was coded independently of infant states as active mouthing or repetitive manipulation of a body part or object for more than 1 sec.

Videorecords of SFP were coded using 1-sec time intervals. Coders were initially trained to reliability using pilot records of mother-infant interactions. Reliability was calculated as both coders observing the same behavior within 1 sec of each other using kappa (κ) for 10% of depressed and 10% of nondepressed dyads. The κ for infant states was .79 for depressed and .88 for nondepressed mother groups. For self-soothing behaviors κ was .86 for depressed and .84 for nondepressed mother groups.

We coded mothers' behavior across the three episodes of the SFP to examine whether depressed and nondepressed mothers complied with the instructions and maintained a still face. Maternal facial, vocal, and tactile expressions of positive (κ=.82) and neutral behaviors (κ=.78) were coded by coders who did not code infant states.

Data Analyses

We converted all duration data to proportions of total interaction time. Because means and variances of proportions are not independent and behaviors were not distributed normally, all proportions were logit transformed for analysis (Afifi & Clark, 1984); untransformed values are presented in tables.

We then investigated proposed transitions between infant states during SF by conducting two sets of sequential analyses. The first set was conducted by representing infant states as event sequential data (Bakeman & Quera, 1995) to focus on transitions and conduct lag analyses. The second set was conducted to examine hypothesized transitions between infant states and self-soothing, formatted as timed sequential data, to introduce temporality into the analysis by framing the transition in terms of time units. Because self-soothing was coded only if the behavior lasted for 1 sec or more, we used a 2-sec time window for analyses. Coded data were formatted for sequential analysis using the Sequential Data Interchange Standard (Bakeman & Quera, 1995). We used Generalized Sequential Querier program version 4.1.2 (Bakeman & Quera, 2004) to conduct sequential analyses of data.

Results

Manipulation Check

A 2 (depression group) X 3 (episodes) repeated-measures GLM showed a significant change in maternal positive behaviors, $F(2,113) = 216.55$, $p < .01$, and in maternal neutral behaviors, $F(2,113) = 142.88$, $p < .01$, across episodes. There were no significant differences in positive, $F(1,114) = 0.34$, ns, and neutral expressions, $F(1,114) = 1.69$, ns, between the depressed and nondepressed mothers during the SF. These results suggested that our manipulation worked equally well for both groups, and depressed and nondepressed mothers showed similar behaviors during the SF.

Infant Response to Still-Face Perturbation

As shown in Table 1, the effects for episode were significant for all infant behaviors, except for object attend. From Baseline to SF, infant negativity and self-soothing increased, social play and monitoring decreased. During SF, infants looked less at mother, spent a considerable amount of time looking away and at objects, and spent about half the time engaging in self-soothing. Recovery was characterized by a carryover of negative affect and monitoring, decreased gaze avert and object attend, and a partial rebound of social play. Comparing Baseline and Recovery episodes, infants were more negative, showed more monitoring, less social play, and looked at objects more, suggesting that infants remained in heightened arousal states. There was a significant Group X Episode interaction only for Gaze Avert, $F(2,113) = 4.55$, $p = .01$, $\eta^2 = .08$, although the effect size was small. Only infants of nondepressed mothers increased in gaze avert from Baseline, ($M=14.23$, $SD=10.02$) to SF ($M=23.15$, $SD=13.38$).

To examine group differences within the SF episode, we conducted simple ANOVAs. The two groups were significantly different only for infant gaze avert, $F(1,114) = 5.77$, $p = .01$, $\eta^2 = .05$. Infants of nondepressed mothers were significantly more likely to avert gaze ($M=23.15$, $SD=13.38$) than infants of depressed mothers ($M=18.21$, $SD=12.76$).

Based on these results, we conclude that although the two groups differed in the proportion of time averting gaze, infants of depressed and nondepressed mothers alike experienced mothers' SF to be negatively arousing.

Sequential Analysis of Infant States in SF

We conducted preliminary analyses, using GLMs, to examine the interactive effect of maternal education (less than vs. at least college educated) and infant birth order (firstborn vs. laterborn) with depression on the conditional probabilities hypothesized to indicate infant ER. Neither factor was statistically significant. Nor was there was any effect of maternal comorbid anxiety on infant ER within the depressed group.

Results of sequential analysis of hypothesized transitions among infant states in the SF are presented in Tables 2A and 2B. As hypothesized, the conditional probability for SocPlay → GazeAvert, was significant in infants of nondepressed mothers (p_{L1} = .49, z = 3.83, p < .01) but not in infants of depressed mothers (p_{L1} = .26, z = −0.38, p > .05).

Our hypothesis that states of disengagement would not be followed by negative state only in infants of nondepressed mothers was confirmed. In infants of depressed mothers, gaze avert and object attend were followed significantly often by negative states (GazeAvert → Negative: p_{L1} = .16, z = 2.95, p < .01, and ObjAttend → Negative: p_{L1} = .15, z = 2.47, p < .01). Infants of nondepressed mothers were also able to convey the need for external regulation by transitioning from Negative → Monitor (p_{L1} = .35, z = 4.21, p < .01); this transition was not significant in infants of depressed mothers.

Sequential Analyses of Infant States and Self-Soothing in SF

Analysis showed that for both groups, self-soothing behaviors were most likely to co-occur during object attend, and least likely to co-occur when the infant was gazing at mother (positive or monitoring) and in negative states. This confirms previous findings that self-soothing behaviors occur at low negative arousal (Stifter & Braungart, 1995).

We examined whether the onset of self-soothing began within 2 sec of the onset of infant negative states (Negative →SSoothing). As shown in Tables 3A and 3B, infants of depressed mothers, but not infants of nondepressed mothers, showed a significant transition from negative to self-soothing behaviors (p_{L2} = .09, z = 2.57, p = .01). The transition from engaged with mother to self-soothe (EngM →SSoothing) was not significant in either group. To examine SSoothing → EngM, we asked whether the onset of engagement with mother was preceded by the offset of self-soothing within a 2-sec time window. SSoothing → EngM was significant only in infants of depressed mothers (p_{L2} = .06, z = 2.17, p < .05).

Discussion

Infants of both depressed and nondepressed mothers demonstrated the "SF effect"; infant negativity and self-soothing increased, and positive states and monitoring decreased, from the baseline episode to SF. In addition, with the exception of gaze avert, there were no significant differences between groups in infant states during SF. This pattern of results, consistent with previous studies, indicates that infants of clinically depressed and nondepressed mothers alike experienced the SF perturbation to be distressing (Moore et al., 2001; Stanley et al., 2004). The SF manipulation worked equally well for depressed and nondepressed mothers; there were no differences in maternal positive and neutral behaviors during SF between the groups.

ER in Infants of Nondepressed Mothers

ER refers to the organization of discrete components of infant behavior in various modalities into a unified system that cycles between processes of excitation and inhibition (Feldman, 2007). Given the absence of group differences in maternal behaviors during SF, we attribute the observed group differences in infant regulatory behaviors to internalized ER mechanisms. We proposed seven transitions as indicative of infant ER in the context of maternal SF, and hypothesized that infants of depressed and nondepressed mothers would show certain transitions and inhibit others. Infants of nondepressed mothers used gaze avert to regulate arousal and refocus attention to objects without resulting in negative states. Gaze aversion has been shown to reduce autonomic arousal (Field, 1981), expected to result from the mother's lack of response to her infant's bid to restore interaction. The use of objects as a source of visual distraction has been shown to increase with development (Cohn &

Tronick, 1987; Mangelsdorf et al., 1995). Self-soothing behaviors were most likely to co-occur during object attend, which might have facilitated attentional focus on objects in the SFP setting and calmed the infant enough to prevent the transitioning to negative states.

Because ER consists of intrinsic and extrinsic processes that modify emotional reactions in the service of one's goals (Kopp, 1989), we hypothesized that infants of nondepressed mothers would use negative states to signal and induce maternal behavior in the context of SF. The significant transition from negative to monitoring in infants of nondepressed mothers suggests that, not only do they show the capacity to transition from a negative to a neutral state, but also seek eye contact with the mother possibly to reinstate normal interaction.

Contrary to expectation, infants of nondepressed mothers did not use self-soothing to modify arousal resulting from distress or engagement with the mother or to facilitate reengagement with the mother. Given that the proportion of time infants self-soothed increased dramatically from Baseline to SF and then decreased during Recovery, it is likely that infants of nondepressed mothers use self-soothing primarily to facilitate visual attention to objects in the immediate environment. Conversely, because their *attentional* regulatory strategies are efficient enough to modulate negative arousal and reengage with the mother, infants of nondepressed mothers might not have to resort to self-directed and more "primitive" forms of ER (Mangelsdorf et al., 1995) that are less likely to be associated with active exploration.

Maternal Depression and Infant ER

Infants of clinically depressed mothers were not able to disengage from a state of social play with the mother by averting gaze. Even when they were in a state of disengagement by averting gaze and focusing attention on objects, infants of depressed mothers transitioned to negative behaviors (fussing, crying, arching back), thereby showing that focusing on an object, possibly a visual distraction, did not serve the regulatory function of inhibiting distress. Given that infants of depressed mothers did not attend to objects any less than infants of nondepressed mothers during SF, it is likely that merely looking at objects does not alter their underlying distress. It is also possible that they do not engage in *sustained* attention to objects. Coding object attend into separate behaviors of scanning (looking at objects for ≤ 2 sec) and focused attention (≥ 3 sec) (Mangelsdorf et al., 1995) may test this hypothesis.

In addition, infants of depressed mothers were not able to transition from negative state to visual monitor, suggesting that they were not able to modulate negative arousal enough to signal to the mother to reinstate normal interaction. Given that there were no group differences in duration of infant negative states, it seems that, although infants of nondepressed mothers are as negative as infants of depressed mothers, the organization or sequence of behaviors differs in the two groups. Whereas negativity follows periods of disengagement for infants of depressed mothers, it precedes visual monitoring in infants of nondepressed mothers.

Infants of depressed mothers used self-soothing behaviors to regulate expressions of distress and to engage with their mothers, even as they did not show the appropriate attentional regulatory capacities that were observed in infants of nondepressed mothers. Depressed mothers are known to lack adequate skills to provide proper ER modeling and training for their infants; this compromises infant development of active regulatory abilities (Feldman, 2007; Feng et al., 2008). When the interactive attempts of infants have not been appropriately responded to over time by their depressed mothers, infants turn to self-directed regulatory behaviors (Tronick & Gianino, 1986). If used as the primary regulatory strategy

under stress, these self-directed behaviors may develop into a stable style of self-regulation. This style may serve an adaptive function for an infant growing up with a depressed mother, but it may become maladaptive in the child's broader social world.

Conclusion

Using a dynamic approach to study *processes* of ER, we found that 5-month-olds of clinically depressed and nondepressed mothers differed in their patterns of regulatory abilities in the context of maternal SF. The results must be seen as limited in generalizability, given that our sample of nondepressed and depressed groups consisted of educated mothers at relatively low risk for psychosocial adversity. However, even infants in these relatively advantaged groups showed differences. Whereas infants of nondepressed mothers employed attention as their primary mode of ER, infants of depressed mothers employed a self-directed strategy of self-soothing to modulate negative arousal and to reengage with mother. This dynamic approach may provide stronger inference that ER has occurred compared to traditional approaches of descriptively quantizing behaviors. This study also advances our understanding of processes underlying infant ER and points to possible mechanisms for the development of long-term maladaptive ER strategies in infants of depressed mothers. Finally, the results suggest effective interventions that target the enhancement of active attentional regulatory skills for infants of depressed mothers.

Key points of the paper

- Maternal depression presents a specific risk for the development of appropriate self-regulatory behaviors in infants.

- The study uses a dynamic approach to examine infant emotion regulation during a modified SFP in infants of depressed and nondepressed mothers.

- Whereas infants of nondepressed mothers employed attention as their primary mode of ER, infants of depressed mothers employed a self-directed strategy of self-soothing.

- The study points to possible intervention strategies for the development of long-term adaptive ER strategies in infants of depressed mothers.

Acknowledgments

Abbreviations

ER   Emotional regulation

SF   Still-face

SFP   Still-face paradigm

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Table 1

Percentage of Time in Infant States and Self-Soothing

Infant Behaviors	Baseline		Still-face		Recovery		Episode F (2, 113)	η^2
	M	SD	M	SD	M	SD		
Gaze Avert								
Nondepressed	14.23	10.02	23.15	13.38	11.67	9.96		
Depressed	16.35	11.91	18.21	12.76	12.78	11.58		
Both	15.10[a]	10.84	21.11[b]	13.29	12.13[c]	10.62	27.63**	.33
Negative								
Nondepressed	1.99	4.24	13.88	21.33	21.30	31.44		
Depressed	3.54	7.94	14.82	21.79	15.72	23.38		
Both	2.63[a]	6.07	14.27[b]	21.43	18.99[b]	28.41	37.24**	.40
Wary[1]								
Nondepressed	0.57	2.22	0.55	1.45	0.66	2.96		
Depressed	0.44	1.02	0.25	0.62	0.36	1.02		
Both	0.52	1.81	0.43	1.18	0.54	2.35		
Monitor								
Nondepressed	21.48	12.54	16.91	16.13	17.78	17.42		
Depressed	25.79	15.58	21.06	17.78	23.58	19.87		
Both	23.27[a]	13.98	18.63[b]	16.88	20.18[b]	18.61	8.23**	.13
Object Attend								
Nondepressed	41.03	21.16	38.74	23.14	34.08	25.45		
Depressed	34.13	19.18	36.54	22.16	32.76	23.93		
Both	38.17[a]	20.56	37.83[a]	22.67	33.53[b]	24.73	4.13**	.07
Social Play								
Nondepressed	16.92	15.06	3.26	5.37	9.67	12.30		
Depressed	13.80	13.29	3.62	7.52	10.62	10.72		
Both	15.63[a]	14.38	3.41[b]	6.32	10.06[c]	11.64	48.17**	.46
Withdrawn[1]								

Infant Behaviors	Baseline		Still-face		Recovery		Episode F (2, 113)	η^2
	M	**SD**	**M**	**SD**	**M**	**SD**		
Nondepressed	0.10	0.81	0.22	1.47	0.26	2.12		
Depressed	1.26	4.98	1.75	7.89	0.14	0.96		
Both	0.58	3.30	0.85	5.22	0.21	1.73		
Self-Soothing								
Nondepressed	17.42	16.52	39.30	28.45	19.83	22.26		
Depressed	18.72	19.14	44.38	23.90	23.70	26.62		
Both	17.96[a]	17.58	41.40[b]	26.69	21.43[a]	24.12	57.32 **	.50

Note. Means with different subscripts are significantly different.

[1] Infrequent behaviors were not analyzed.

*
$p < .05$,

**
$p < .01$

Table 2

Table 2A. Infant State Transitions during SF in Infants of Nondepressed Mothers

Transition	Conditional Probability (p_{L1})	Adjusted residual z	Odds Ratio (OR)	p
Social Play → Gaze Avert	.49	3.83	2.33	<.001
Gaze Avert → Negative	.11	1.44	1.24	.15
Object Attend → Negative	.11	1.52	1.26	.13
Negative → Monitor	.35	4.21	1.90	<.001

Table 2B. Infant State Transitions during SF in Infants of Depressed Mothers

Transition	Conditional Probability (p_{L1})	Adjusted residual z	Odds Ratio (OR)	p
Social Play → Gaze Avert	.26	−.38	0.91	.70
Gaze Avert → Negative	.16	2.95	1.65	<.01
Object Attend → Negative	.15	2.47	1.54	.01
Negative → Monitor	.24	.18	1.04	.86

Table 3

Table 3A. Transitions between Infant States and Self-Soothing during SF in Infants of Nondepressed Mothers

Transition	Conditional Probability ($p_{1,2}$)	Adjusted residual z	Odds Ratio (OR)	p
Negative → Self-Soothing	.06	.58	1.10	.56
Engagement with mother → Self-Soothing	.04	−.29	0.96	.77
Self-Soothing → Engagement with mother	.04	−.30	0.96	.76

Table 3B. Transitions between Infant States and Self-Soothing during SF in Infants of Depressed Mothers

Transition	Conditional Probability ($p_{1,2}$)	Adjusted residual z	Odds Ratio (OR)	p
Negative → Self-Soothing	.09	2.57	1.56	.01
Engagement with mother → Self-Soothing	.05	1.04	1.18	.29
Self-Soothing → Engagement with mother	.06	2.17	1.39	.03