The role of maternal self-regulation on emotion regulation patterns of 6-month old infants during the Still Face Paradigm

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Abstract

Objective: Poor emotion regulation in early development has been related to negative child outcomes and is expected to be influenced by interactions with primary caregivers. This study examines the relation between infant emotion regulation and maternal self-regulation. *Method:* The sample consisted of 132 infant-mother dyads. Maternal emotion regulation (ER) problems and executive functioning (EF) problems were assessed during pregnancy by means of the Difficulties in Emotion Regulation Scale and the Behavioral Rating Inventory of Executive Function—Adult version. At six months of age, infant's behavioral and physiological stress responses were observed during the Still Face Paradigm (SFP). *Results:* In response to the still face, infants showed an increase in heart rate and negative affect, and a decrease in positive affect and gaze. Infants of mothers with more ER problems showed more reactivity on heart rate, and arching and squirming. During the still face, infant self-soothing behavior increased. In response to the reunion positive affect, gaze, self-soothing behavior and negative affect increased, while arching and squirming behavior decreased. Infants of mothers with more ER problems, but few EF problems, showed less gaze during the still face, and higher levels of negative affect in general. *Conclusion:* This study underlines that a mother's capacities to self-regulate influence the infant's stress system and the emotional development of their infant. Helping mothers to enhance their own ER capacities could possibly decrease the risk for future psychopathology for their infants.

Key words: Infant emotion reactivity, infant emotion regulation, heart rate, Still Face Paradigm, maternal emotion regulation, maternal executive functioning.

Introduction

Emotion processes are conscious and unconscious behaviors, skills and strategies, that serve to modulate, inhibit, and enhance emotional experiences and expressions (Calkins & Hill, 2007). In the literature regarding typical and atypical child development there has been a large emphasis on the importance of self-regulation, which refers the ability to manage one's emotions, attention, physiology, and behavior in a way that promotes competent functioning (Bosquet Enlow et al., 2011). The regulation of emotion processes develops fast in the first years of life and advances more slowly into adulthood (Eisenberg, Spinrad, & Eggum, 2010; Kopp, 1989). Poor regulation in early development is assumed to influence later development, therefore disruptions to regulatory processes during the first years of life may have harmful and lasting effects on later child functioning (Eisenberg et al., 2010), and patterns of emotion dysregulation may even become symptoms of psychopathology (Cole, Michel, & Teti, 1994). For example, poor emotion regulation has been negatively related with coexisting or later development of externalizing problems (Hill, Degnan, Calkins, & Keane, 2006; Rydell, Berlin, & Bohlin, 2003) and internalizing problems in children (Feldman, 2009; Buckner, Mezzacappa, & Beardslee, 2009; Spinrad, Eisenberg, Gaertner, Popp, & Smith, 2007). Besides a child's innate traits, such as temperament, a large influence on the development of emotion regulation could be sought in the interaction with the environment, mostly the family (Eisenberg, Cumberland, & Spinrad, 1998; Rothbart & Bates, 2006).

The impact of the family on children's emotion regulation occurs in three ways: (a) learning through observation, modeling, and social referencing; (b) parenting practices concerning emotion management; and (c) the emotional atmosphere of the family via parenting style, the attachment relationship, expressiveness in the family, and the marital relationship (Morris, Silk, Steinberg, Myers, & Robinson, 2007). Most studies have focused on the last pathway by researching maternal style, maternal sensitivity and attachment relationships predicting emotion regulation (Kochanska, Philibert, & Barry, 2009; Haltigan, Leerkes, Supple, & Calkins, 2014). However, few studies have specifically explored the relation between a mother's emotion regulation and the emotion regulation of her infant (Morelen, Shaffer, & Suveg, 2014).

The current study seeks to fill this gap in the literature by studying mothers' emotion regulation as a variable that could endorse or hamper the emotional development of their infant. Furthermore, the relation between infant emotion regulation and maternal self-regulation more in general will be explored as well, by examining the role of maternal executive functioning. Knowledge of the role of a mother's capacities in self-regulation including emotion regulation in relation to her infant's emotion regulation skills may strengthen theoretical models of emotional development and may facilitate the selection of objectives for prevention and intervention related to children's emotional development.

Infant's Emotion Regulation

Emotion processes are dynamic in which reactive and regulation dimensions alternate in time (Calkins & Hill, 2007). Reactivity refers to the speed and intensity of initial activation of physiological, attentional, emotional, and motoric responses evoked by various stimuli. Reactivity reflects biological biases to specific response patterns that occur from a combination of genes and biological influences (Fox & Calkins, 2003; Rothbart & Sheese, 2007) and individual differences in reactivity have been observed from the second trimester of the prenatal period, with continuity across later development (DiúPietro, 2000).

Emotion regulation has been generally envisioned as internal and external processes that are involved in starting, preserving and adapting the occurrence, intensity, and expression of emotions to achieve one's goals (Calkins & Hill, 2007; Eisenberg & Morris, 2002). These goals can be described in terms as the protection of oneself from becoming overwhelmed or disorganized, the modulation of one's emotional expressions, and the organization of behaviors in social interactions (Bosquet Enlow, Egeland, Carlson, Blood, & Wright, 2013). Like reactivity, regulation is likely affected by biologically-based individual differences (Rueda & Rothbart, 2009), however, interactions with primary caregivers have been suggested to be of major influence (Eisenberg, Spinrad, & Eggum, 2010).

In the first months of life infant's main focus is the maintenance of physiological homeostasis, for which it relies mainly on its caregiver (Loman & Gunnar, 2010). From birth, infants show regulatory behaviors that serve as an adaptive survival function (Feldman, Dollberg, & Nadam, 2011). These behaviors, such as self soothing, calming self-talk, or proximity seeking, decrease negative emotions in stressful circumstances, for instance, during the Still Face Paradigm (SFP) (Mesman, Van Ijzendoorn, & Kranenburg, 2009). From three to six months of age, infants experience a large transition in development, in which the dimension of control expands. The development of attention mechanisms and simple motor skills enable the infant to employ small behaviors that modify arousal levels. This results in coordinated engagement and disengagement of attention, thus increasing the infant's control dimension (Kochanska, Coy, & Murray, 2001). In circumstances that evoke negative affect infants are now adept to engage in self initiated distraction, such as shifting attention from a negative event to a positive distracter (Calkins and Hill, 2007), which can help them to diminish distress from the negative event. Children at the age of three who were better able to divert from a distressing stimulus showed less anger, as reported by their mothers (Crockenberg, Leerkes, & Barrig Jo, 2008).

The Still Face Paradigm

Infant's emotion regulation capacities can be examined by means of a social interaction task called the Still Face Paradigm (SFP), which is known to elicit infant distress. The SFP, a widely used experimental procedure for examining infant social and emotional development (Mesman, Van IJzendoorn, & Bakermans-Kranenburg, 2009), is designed by Tronick and colleagues and consists of three episodes: the play episode, the still-face episode and the reunion episode (Tronick, Als, Adamson, Wise, & Brazelton, 1978). During the SFP the infant and mother are observed in a face-to-face interaction consisting of three episodes: (a) a baseline episode with normal interaction (play episode), (b) the 'still-face' episode in which mother holds a neutral face and becomes unresponsive to the infant, and (c) a reunion episode in which mother returns to normal interaction with her infant (Mesman et al., 2009).

Previous studies have shown that the still-face evokes behavioral changes and physiological responses in infants, also referred to as the still-face effect. Mesman and colleagues (2009) report in their meta-analysis an overall pattern with reduced infant gaze and positive affect and increased negative affect during the still-face compared to the play episode. From the still-face episode to the reunion episode increases in positive affect and gaze (the recovery effect) but no change in negative affect were found. Moreover, a carry-over effect was found: when comparing the play episode with the reunion episode infant positive and negative affect do not return to baseline levels, but stay lower and higher respectively (Mesman et al., 2009).

Cardiovascular Reaction to the Still Face Paradigm

The still-face effect also emerges in infant's physiological responses, indicating a reaction of the autonomic nervous system. One indicator of the autonomic nervous system is the cardiovascular reaction, specifically the heart rate, which can easily be measured in infants via non-invasive methods (Brownley, Hurwitz, & Scheiderman, 2000). Increases in heart rate have been used as a measure of sympathetic input to the heart, reflecting a reaction to fearful stimuli and contexts (Kagan, Reznick, & Snidman, 1994). During the still-face episode, heart rate increases, while during the reunion episode heart rate decreases, although the heart rate mostly does not return to baseline level (Mesman, Van IJzendoorn, & Bakermans-Kranenburg, 2009; Moore et al., 2009). Researchers have suggested that individual variation in heart rate during separate episode of the SFP is indicative of infant regulation skills (Haley & Stansbury, 2003). Moreover, baseline heart rate, heart rate reactivity and the recovery of heart rate following distress have been related to later cognitive and behavioral functioning in children and adults. (Fox, Schmidt & Henderson, 2000). Hence, infant cardiovascular reaction to distress makes an essential topic of interest in developmental psychopathology.

Maternal Emotion Regulation

Emotion dysregulation can include maladaptive duration, valence, and/or intensity of emotions causing functional interference (e.g., Linehan, Bohus, & Lynch, 2007). Emotion dysregulation does not mean completely unregulated emotion expression, because often efforts to regulate emotion are still evident (Cole, Michel, & Teti, 1994). This means that emotion regulation and dysregulation are separate constructs that are related to each other. In the current study, self-reported maternal emotion dysregulation relates to when a mother perceives her emotions to be overwhelming, uncontrollable, confusing, or interfering with goals (Gratz & Roemer, 2004).

Several studies have shown proof of the relation between parental emotion regulation and child emotion regulation. Morelen, Shaffer and Suveg (2014) found mother's self-reported emotion dysregulation to be positively related to child emotion dysregulation and negatively related to children's adaptive emotion regulation. A longitudinal study found that emotion dysregulation of boys in the age 17 to 19 years was predicted by parental emotion dysregulation when the boys were 9 to 13 years old (Kim, Pears, Capaldi, & Owen, 2009).

Gottman and colleagues (1996) developed a model regarding parental meta-emotion philosophy, offering a theoretical framework for the influence of a mother's own feelings on the emotion regulation of her infant. According to this model, a parent's thoughts and feelings about emotions, including their ability to regulate their own emotions, affect parenting behavior, which in turn affects child outcomes. However, Morris et al. (2007), provide with their tripartite model that the factors affecting infant's emotional development can be seen as dynamic and in interaction with one another.

One route by which infants gain knowledge of emotion regulation is by observation of maternal expressivity, and coping behaviors (Eisenberg et al., 1998; Morris et al., 2007). Infants of mothers who are emotionally dysregulated are thought to observe more maladaptive emotion regulation methods, compared to infants of emotionally well regulated mothers. This view is coherent with past research where similar patterns of emotion management between mothers and infants have been found (Bariola, Gullone, & Hughes, 2011).

Morelen et al. (2014) have found partial support for the mediating role of emotion parenting behaviors on the link between maternal and child emotion regulation. Mothers who experience emotions as overwhelming, intense, or out of control likely have more difficulties coping in stressful situations, which could make it challenging for them to constructively help their infant with their emotional experiences (Gratz and Roemer (2004). In addition, Morelen et al. (2014) suggest that evocative interactions between mother and infant, in which one member of the dyad becomes dysregulated, could trigger the other in becoming dysregulated as well, resulting in emotional escalation for both. Finally, a predisposition to maladaptive emotion regulation with heritable components may play a role for both mothers and infants (Rhee et al., 2012).

Maternal Executive Functioning

Executive functioning is an umbrella term for a set of higher order cognitive processes, such as emotion regulation, effortful control, self-control, inhibitory control, executive ability, or volitional control (Eisenberg & Spinrad, 2004). In their study to relationships between parent and child executive functioning, Jester and colleagues (2009) found that mother's and father's executive functioning were associated with child's executive functioning, independently of parental IQ, indicating that elements of executive functioning are differentiable from IQ, and are intergenerationally transmitted.

However, there are not many studies directly linking parent executive functioning and child emotion regulation, and these are generally restricted to temperament or parenting practices (Bridgett, Burt, Laake, & Oddi, 2013). In several studies poorer maternal executive functioning has been related to parental practices such as less child-related involvement, unsupportive responses to negative child affect, more incoherent discipline routines, more negative reaction towards children and more disorganized households (Deater-Deckard, Sewell, Petrill, & Thompson, 2010; Mokrova, O'Brien, Calkins, & Keane, 2010). Similarly, better maternal regulation has been related to positive parenting practices and more regulated emotion in the child (Cumberland-Li, Eisenberg, Champion, Gershoff, & Fabes, 2003).

Current study

The focus of the current study is the possible relation between maternal emotion regulation, maternal executive functioning and infant's stress response. The physiological and behavioral stress reactivity and regulation of the infant is examined at six months of age, by means of the Still Face Paradigm. This study is a contribution to the existing literature, by examining the relation between infant's stress response patterns and maternal regulation competences, which to date has not been investigated thoroughly.

The first aim of this study is to investigate infant emotion responses to the still face paradigm and to detect whether the still face effect is present. It is hypothesized that infants will exhibit a physiological and behavioral stress reaction to the still face episode. This stress reactivity will be perceptible in an increase in heart rate, negative affect, and self-soothing behavior, and a decrease in positive affect and infant gaze from the play to the still face episode. Moreover, it is expected that infants will display stress recovery during the reunion episode. Stress recovery will be observed in a decrease in heart rate, negative affect, and self-soothing behavior, and an increase in positive affect and infant gaze, from the still face to the reunion episode.

The second aim is to explore the relation between infant's stress response patterns and maternal regulation competences. Hypotheses regarding maternal emotion regulation and maternal executive functioning problems are depicted respectively. It is expected that infants whose mothers report more emotion dysregulation problems exhibit enhanced stress reactivity compared to infants whose mothers report fewer dysregulation problems. Additionally, it is anticipated that infants of mothers with more emotion dysregulation problems display decreased stress recovery in comparison to infants of mothers with fewer dysregulation problems. Concerning maternal executive functioning, it is hypothesized that infants whose mothers report more problems in executive functioning, show enhanced stress reactivity and less stress recovery in comparison to infants of mothers with fewer executive functioning problems.

Method

Background

The sample in this study was drawn from a larger longitudinal study named ‘Mother-Infant Neurodevelopment Study-Leiden’, which consists of five assessments and focuses on the development of first-born infants of mothers aged 17-25 years. The study focused on mothers in this specific age range, because they depend on standard facilities (there are special services for mothers aged 17 and younger), and are expected to be capable of rearing their children by themselves, despite of their young age. Mothers were recruited from all parts of Netherlands by means of advertisements and recruitment at midwifery clinics and pregnancy-fairs. Exclusion criteria were severe drug addiction, severe psychiatric problems, severe medical complications for mother or infant, insufficient fluency in the Dutch language and an IQ below 70 (estimated by those entering the mothers in the study). The ethics board of the Faculty of Social Sciences and the medical ethical board of the Leiden University Medical Centre gave approval for the study. Mothers were first interviewed at 27 weeks of pregnancy. Subsequently, mother-infant dyads took part in four more assessments, specifically a home visit when the infant was 6 months old, a lab-visit at infant age of 12 months, a second home visit when the infant was 20 months, and finally a second lab-visit at 30 months. Mothers received a gift card and a present for the infant after each assessment and reimbursement for their travel expenses for the visits at the Leiden University Babylab. The current study uses data that was obtained during the first and second assessments.

Participants

The sample consisted of 143 mothers and their infants. Dyads were excluded from the present sample due to abortion of Still Face Paradigm (n=4), use of a pacifier during the Still Face Paradigm (n=2), or technical problems with physiology measurements (n=5). The remaining sample consisted of 132 dyads. Demographic characteristics for those who were included and those who were excluded were not different with respect to ethnicity or child development. However, those who were excluded were on average younger ($t(141)=-2.90$, $p=.004$), had a lower mean maternal education level ($t(141)=-2.56$, $p=.012$) and a lower mean score on the Wechsler Adult Intelligence Scale-III-NL (Wechsler, 1997) subtests Vocabulary $t(139)=-3.47$, $p<.001$) and Matrix Reasoning $t(140)=-2.01$, $p<.046$).

Demographics characteristics of the current sample are presented in Table 1. The majority of the mothers were Caucasian (82.6%). At the time of the first appointment, mothers had a mean age of 22.49 years, and for most mothers (56.1%) the highest level of education completed was high school. At the second appointment, infants' mean score on the Bayley Scales of Infant Development–II (Bailey, 1993) was in the average range (M=101.52). Furthermore, mothers' mean scores regarding intelligence measures on the Wechsler Adult Intelligence Scale-III-NL were in the average range on the subtests Vocabulary (M=8.81) and Matrix Reasoning (M=10.19).

Table 1. Demographic information of sample

	N	%	Mean	*SD*	Min.	Max.
Maternal age	132		22.49	2.35	17	27
BSID infant development score	124		101.52	18.49	55	145
WAIS Vocabulary	130		8.88	3.11	2	15
WAIS Martix Reasoning	131		10.23	2.20	1	17
Maternal education						
Primary school	12	9.1				
Secondary school	74	56.1				
College	30	22.7				
Higher education or university	16	12.1				
Maternal ethnicity						
Caucasian	109	82.6				
Surinam/Antillean	9	6.8				
Other or mixed	14	10.6				

Procedure

The first home visit was conducted in approximately the 27^{th} week of pregnancy, the expectant mother completed several questionnaires including the Behavioral Rating Inventory of Executive Function—Adult version (BRIEF-A; Roth, Isquith, & Gioia, 2005) and the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004).

When the infants were approximately 6 months, researchers conducted a second home visit. The visit was planned at the time comfortable for the participants, preferably half an hour before the anticipated wake-up time of the infant, so that the infant would be as alert as possible during the visit. The home visit consisted of two parts: assessments regarding the mother-infant dyad and assessments regarding only the mother. Depending on the daily rhythm of the dyad, the visit could start with either of the two parts.

The first of the infant-mother assessments was a free play session (3 minutes). The researchers brought a play mat, several toys and used a video camera with tripod to record the assessment. Mothers were instructed to play with their infant like they usually would. The second assessment was a Teaching Task (5 minutes). The researchers gave the mothers stacking cups and a ring tower. Both toys were fairly difficult for infants this age, so mothers were encouraged to teach their infant to play with the toys. Subsequently VU-AMS electrodes were attached to the infant, followed by the two minute baseline physiology measure in which infants watched a two minute video or were sung to. The next assessment was the Still Face Paradigm (SFP), consisting of three episodes of two minutes each, based on the paradigm used by Tronick, Als, Adamson, Wise, and Brazelton (1978). The infant was positioned into a car seat on a table facing the mother, who was seated on a chair. The faces of both mother and infant are recorded on video camera by means of a wooden frame with a mirror behind the infant. The frame also restricted the infant to look around, or see the researchers. Pacifiers or toys were not allowed for the infant. The SFP consists of three episodes: (1) the Play episode in which mothers were asked to play with their infant; (2) the Still Face episode where mothers were asked not to interact with their infant, to sit motionless and look at their infant with a neutral face; and (3) the Reunion episode in which mothers were allowed to regain the interaction with their child. After the SFP, during the recovery phase, mothers could hold and calm their infant if necessary. The last infant assessment used in the current research was the

Bayley Scales of Infant and Toddler Development – II (BSID-II), used to assess the level of the infant's mental development.

During the second home visit there were two assessments regarding the mother. Mothers completed an interview regarding the last trimester of the pregnancy and the development of their infant. Moreover, mothers completed two subtests of the Wechsler Adult Intelligence Scale -III- NL (WAIS-III-NL): Vocabulary and Matrix Reasoning.

Measures

Maternal emotion regulation. Mothers reported on their emotion dysregulation by completing the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). This questionnaire is extensively used in psychiatric research and is designed to obtain a measure of the impact of difficulties in emotion regulation on daily life (Fowler et al., 2014).

The DERS items reflect problems in four dimensions of emotion regulation: (1) awareness and comprehension of emotions (e.g. "I pay attention to how I feel." reverse scored); (2) acceptance of emotions (e.g., "When I'm upset, I feel ashamed with myself for feeling that way"); (3) maintaining goal-directed behavior when facing negative emotions (e.g. "When I'm upset, I have difficulty getting work done"); and (4) access to effective emotion regulation strategies (e.g. "When I'm upset, I believe that wallowing in it is all I can do"). Mothers were asked to rate the frequency with which each item applied to them on a 5-point Likert scale from 1 (almost never) to 5 (almost always). Eleven items were recoded so that on every item higher scores are indicative of more emotion regulation difficulties. The measure yields six subscales and a total score.

The DERS has been validated in a variety of populations (Fowler et al., 2014), resulting in adequate reliability and validity scores (e.g., internal consistencies from .80 to .89) for the overall scale (Gratz & Roemer, 2004). For the current study the total score of the scale was used as a measure of maternal emotion dysregulation (α=.91). The DERS does not provide a clinical cut-off score for problematic emotion regulation difficulties. In order to be able to compare mothers with low and high levels of emotion dysregulation, participants were divided into two groups, those above and those below the mean total score.

Maternal executive functioning. In order to measure maternal executive functioning, mothers completed the Behavior Rating Inventory of Executive Function- Adult version (BRIEF-A; Roth, Isquith, & Gioia, 2005). This self-report questionnaire consists of 75 items rated of a scale from 1 (never) to 3 (often), yielding a total score between 75 and 225. Higher scores indicate greater difficulties with the executive function.

The BRIEF-A bears nine scales, divided over two indices: Behavioral-Regulation Index (BRI) and the Metacognition Index (MCI). The BRI is an estimate of the skills to regulate behavior and emotional responses. It is composed of four subscales: Inhibit scale (e.g. “I have problems waiting my turn”); Shift scale (e.g. “I get disturbed by unexpected changes in my daily routine”); Emotional Control scale (e.g. “I get upset quickly or easily over little things”); Self-Monitor scale (e.g. “I don't think about consequences before doing something”). The MCI assesses the capability to resolve difficulties systematically through planning, organization and maintaining information in working memory. The MCI contains five scales: Initiate scale (e.g. “I need to be reminded to begin a task even when I am willing”); Working Memory scale (e.g. “I have trouble with jobs or tasks that have more than one step”); Plan/Organize scale (e.g. “I misjudge how difficult or easy tasks will be”); Organization of Materials scale (e.g. “I leave my room or home a mess”). The scores on all subscales yield into one total score, which provides a general estimate an adult’s experience of their executive functioning in daily life activities.

The BRIEF-A is designed for adults between the ages 18 to 90 years and has been validated in several studies with clinical and non-clinical samples (Ciszewski, Francis, Mendella, Bissada, & Tasca, 2014; Gioia, Isquith, Guy, & Kenworthy, 2000), resulting in moderate to high internal consistency (α = .93 to .96) for the total score (Roth et al., 2005). In the current study, analyses were performed on the raw scores of the total score (α = .95). Similar to emotion dysregulation, participants were divided into two groups, those above and those below the mean total score on executive functioning.

Infant’s behavioral stress response. Infant’s reactions on the SFP were recorded on video and afterwards coded by trained researchers using a coding manual (Smaling & Suurland, 2013), based upon the scoring systems of Miller and Sameroff (1998). Infant’s behavioral stress reactions were coded for each episode of the SFP, divided into two indices: Reactivity and Regulation. Scores range from 0 (low) to 3 (high).

Reactivity scores include the categories Positive affect and Negative affect. Positive Affect refers to the amount the infant smiles (not necessarily toward mother). If an infant doesn't smile or has a neutral or negative affect a low score is given. High scores are given when the infant smiles predominantly throughout a segment, or shows intense positive affect. Negative Affect is defined as the amount the infant fusses or cries. A low score relates to no negative affect throughout the entire segment. A high score is given when the infant cries loud for longer periods of time, or cries less intense but throughout segment.

Regulation scores include the categories Gaze, Self- Soothing behavior, and Arching/ Squirming. Gaze refers to the amount of time that the infant gazes at mother's face or makes eye contact with mother. Infants who are totally unresponsive to mother and do not seek mother's attention receive a low score. Infants who consistently make eye contact with their mother receive a high score. Self-soothing behavior includes sucking (on own body, object, or hands of the mother) or clasping with the hands. A low score indicates no engagement, whereas a high score represents predominant or high engagement in self-soothing. Arching/squirming refers to the amount the infant is squirming in the seat, or arching its back, hereby showing that it wants to get out. A low score denotes no arching and squirming, whereas a high score indicates predominant or intense arching and squirming.

In order to obtain a measure for inter-rater reliability 23 videos (25%) were double coded and the intra-class correlation coefficients were calculated. For all measures of infant behavior the inter-rater reliability suggested substantial agreement (ICC > .793 and κ > .616, see Table 2.).

Table 2. Inter-rater reliability of infant responses

	Intra-class correlation coefficient (ICC)	Kappa (κ)
Reactivity		
Positive Affect	.793	.751
Negative Affect	1.00	.757
Regulation		
Gaze	.999	.758
Self-soothing behavior	1.00	.771
Arching and squirming behavior	.999	.616

The intra-class correlation coefficient and Kappa were computed over 23 videos.

Infant physiological stress response. Physiological stress responses of the infants were measured with the Vrije Universiteit-Ambulatory Monitoring System (VU-AMS) (Klaver, De Geus, & De Vries, 1994), which recorded the electrocardiogram (ECG), the impedance cardiogram (ICG) and the skin conductance level (SCL) of the infant. Seven electrodes were attached to the back and chest of the infant and two on the infant's foot. For the current study only measures from ECG are used. The three ECG electrodes (ConMed Huggables REF 1620-001) were positioned below the right collar bone, on the right side between the lowest two ribs, and on the left side two to four cm below the nipple (Van Dijk et al., 2013). The electrodes were attached with lead wires to the VU-AMS. Previous to the assessments of the stress paradigm, the VU-AMS was connected to a laptop with a serial cable, in order to inspect the data with the Vrije Universiteit Data Analysis Management Software (VU-DAMS). During the assessments the VU-AMS device was detached from the laptop, and the VU-AMS recorded signals during the entire assessment. For accuracy in the time registration of the heart rate measures, a control marker was set with the VU-AMS.

In order to acquire an estimate of the heart rate in resting state, a two minute baseline measure was carried out, preceding the stress paradigm. Subsequently, the Still Face Paradigm (SFP) was conducted, followed by 5 minutes of recovery. Afterwards the data was extracted with the VU-DAMS software suite version 2.0 and ECG measures were used to compute the average heart rate. ECG is the registration of the electrical impulses generated by the polarization and depolarization of the heart over time, resulting in a waveform (see Figure 1). The R-peak is used as an indicator of the heart rate. If R-peaks were not detected automatically, they were inserted by using the mean. Heart rate in beats per minute was calculated every 30 seconds, and average heart rates were calculated for Baseline, Play, Still Face 1st minute (SF1), Still Face 2nd minute (SF2), Reunion 1st minute (RE1), Reunion 2nd minute (RE2), and Recovery (RC). The first and second minute of the Still face and Reunion episode were extracted and analyzed independently, so changes within these episodes due to reaction of the nervous system might be detected.

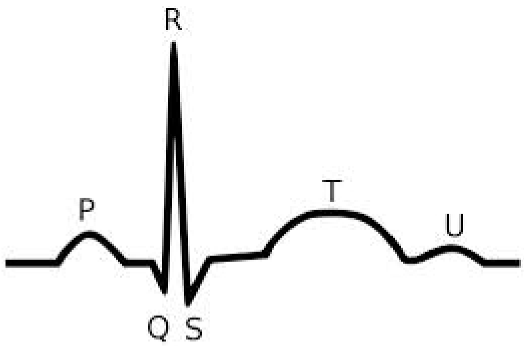

Figure 1. ECG-complex with R-peak.

Data analyses

All statistical analyses were conducted using IBM Statistical Package for the Social Sciences (IBM SPSS, version 21.0). Prior to the main analyses data inspection was performed in order to check for missing values, outliers and the assumptions of normality. Scores that diverged more than three standard deviations from the mean were regarded as outliers, and were substituted with the next largest value. All data were normally distributed. Correlation analyses were conducted in order to inspect coherence in the data. Composite scores for questionnaires were only computed when there was sufficient correlation between variables. Correlations were conducted between all variables and background variables (maternal age, maternal education level, maternal intelligence, infant development). When correlations were significant, the background variable would be included in all further analysis of the specific variable. Also, correlation between maternal emotion regulation problems, maternal executive functioning problems and infant stress responses will be examined, prior to main analysis.

Repeated measures analyses of variance were conducted to detect changes in heart rate and infant behavioral responses (Positive affect, Negative affect, Gaze, Self-soothing behavior and Arching and squirming behavior) due to the stress paradigm. More specifically, analyses were conducted to detect whether the still face effect is present (changes from Play to SF2) and to detect stress recovery during the reunion episode (changes from SF2 to RE2 and from Play to RE2). It was expected a priori that some time would be required for activation or deactivation of the nervous system. Therefore the second minute of the Still Face and the Reunion were used, because those would offer a more accurate representation of the actual physiological response.

To inspect the role of maternal emotion regulation on infant physiological and behavioral stress responses, repeated measures of analysis of variance were conducted with maternal emotion regulation (low versus high problem level) as between-subjects factor. More explicitly, changes were examined with respect to stress reactivity (respectively Play – SF2 and SF1 – SF2) and stress regulation (respectively SF2 – RE2, RE1 – RE2 and Play – RE2). Similar repeated measures of analysis of variance were conducted to examine the role of maternal executive functioning on infant stress responses, with maternal executive functioning (low versus high problem level) as between-subjects factor and stress reactivity (respectively Play – SF2 and SF1 – SF2) and stress regulation (respectively SF2 – RE2, RE1 – RE2 and Play – RE2) as within-subject factors. The partial eta squared was used as effect size for all repeated measure analyses of variance.

Results

Preliminary Analyses

Maternal emotion regulation. The mean total score of maternal emotion regulation was 75.70 ($SD = 17.65$, $N = 132$, range = 83) measured with the DERS questionnaire during the first appointment. In relation to background characteristics (maternal age, maternal education level, maternal intelligence, and infant development) maternal emotion regulation showed a weak negative correlation to maternal age ($r = -.27$, $p < .001$), indicating more problems for younger women. Mothers were divided into two groups based on the mean total score, those with a low level of emotion regulation problems (LowERP; below the mean, $N = 73$) and those with a higher level of emotion regulation problems (HighERP; above the mean, $N = 59$). Mothers with fewer emotion regulation problems performed on average better on WAIS-III-NL-Matrix Reasoning, compared to mothers with more emotion regulation problems [$M_{LowERP} = 10.59$, $M_{HighERP} = 9.78$, $t(129) = 2.13$, $p = .035$]. There were no significant differences between the two groups regarding background variables maternal age [$t(130) = 1.66$, $p = .099$], maternal education level [$t(129) = .54$, $p = .590$], WAIS-III-NL-Vocabulary [$t(106.7) = 1.28$, $p = .203$], or Bailey Scales for Infant and Toddler Development - II [$t(122) = -.44$, $p = .662$].

Maternal executive functioning. On the BRIEF-A, measuring maternal executive functioning, the mean total score was 116.03 ($SD = 20.21$, $N = 132$, range = 98). Maternal executive functioning correlated significantly with maternal age (r = -.28, p = .001), indicating poorer EF with younger age. Maternal emotion regulation and maternal executive functioning were also strongly significantly correlated, r = .67, p < .001. Similar to the classification based on the emotion regulation problem scores, participants were also divided into two groups based on executive functioning problems: those with a low level of executive functioning problems (LowEFP: below the mean, N = 72) and those with more problems in executive functioning (HighEFP; above the mean, N = 60). Mothers in the LowEFP group were on average older than mothers in the HighEFP group, [M_{LowEFP} = 23.19, $M_{HighEFP}$ = 21.65, $t(130)$ = 3.99, p < .001]. There were no significant differences between the two groups with respect to maternal education level [$t(129)$ = 1.71, p = .090], WAIS-III-NL-Vocabulary [$t(128)$ = 1.73, p = .085], WAIS-III-NL-Matrix Reasoning [$t(129)$ = -1.08, p = .283], or Bailey Scales for Infant and Toddler Development –II [$t(122)$ = .23, p = .821].

Infant physiological response. The average heart rate of the infant was measured at seven time points, of which the descriptives are depicted in Table 3. The total scores of maternal emotion regulation problems and maternal executive functioning problems showed no correlations with any heart rate measures, all $r \leq .134$, $p \geq .125$ (not shown in table), when corrected for maternal age, all $r \leq .118$, $p \geq .181$ (Appendix, Table 6). At group level however, an independent samples t-test showed that infants in the LowERP group had on average a lower mean heart rate during SF1, compared to infants in the HighERP group [M_{LowERP} = 144.19, $M_{HighERP}$ = 148.83, $t(130)$ = -2.15, p = .033]. There were no significant differences between the LowERP and HighERP groups on other heart rate measures, all $t \leq -.58$, $p \geq .120$. Neither were there any significant differences on heart rate measures when comparing infants of mothers with low and high executive functioning problems, all $t \leq 1.16$, $p \geq .238$. (Appendix, Tables 7 and 8, respectively).

Table 3. Descriptives of Physiological Measures.

	N	*M*	*SD*	Skewness	Skewness *SE*	Kurtosis	Kurtosis *SE*
Baseline	132	134.95	12.87	.06	.21	-.16	.42
Play	132	140.87	11.70	.04	.21	.04	.42
Still Face 1	132	146.27	12.48	.02	.21	.35	.42
Still Face 2	132	147.41	13.68	.15	.21	.03	.42
Reunion 1	132	147.31	15.12	.21	.21	1.04	.42
Reunion 2	132	147.14	16.39	.20	.21	.28	.42
Recovery	132	143.65	10.02	-.11	.21	.66	.42

Table 4. Descriptives of behavioral measures during the Still Face Paradigm.

	*N**	*M*	*SD*
Reactivity			
Positive Affect Play	132	2.05	.99
Positive Affect Still Face 1	131	.44	.68
Positive Affect Still Face 2	130	.42	.72
Positive Affect Reunion 1	131	1.53	1.07
Positive Affect Reunion 2	131	1.37	1.10
Negative Affect Play	132	.66	.88
Negative Affect Still Face 1	131	.93	1.05
Negative Affect Still Face 2	131	.95	1.16
Negative Affect Reunion 1	131	1.14	1.19
Negative Affect Reunion 2	131	1.22	1.17
Regulation			
Gaze Play	132	1.61	.76
Gaze Still Face 1	131	1.20	.72
Gaze Still Face 2	131	1.08	.74
Gaze Reunion 1	131	1.43	.76
Gaze Reunion 2	131	1.40	.89
Self Soothing behavior Play	132	.98	1.03
Self Soothing behavior Still Face 1	131	.80	1.14
Self Soothing behavior Still Face 2	131	1.01	1.21
Self Soothing behavior Reunion 1	130	.66	.90
Self Soothing behavior Reunion 2	130	.82	1.02
Arching/Squirming Play	132	.78	.98
Arching/Squirming Still Face 1	131	1.00	.96
Arching/Squirming Still Face 2	131	1.08	1.09
Arching/Squirming Reunion 1	130	.58	.80
Arching/Squirming Reunion 2	130	.54	.87

* For three infants not all episodes of the SFP could be coded because the camera view was blocked.

Infant behavioral response. Infant reactivity scores (Positive affect and Negative affect) and infant regulation scores (Gaze, Self- Soothing behavior, and Arching/ Squirming) were measured at five time points during the SFP (Table 4). The total scores of maternal emotion regulation problems showed no correlations with any behavior measures (Appendix, Table 9 and 10). At group level, there were no significant differences between the LowERP group and the HighERP group on any episode of the SFP for infant behavioral responses

(Appendix, Table 11). The total scores of maternal executive functioning problems showed a significant correlation with infant arching and squirming during the first minute of the reunion, $r = .182$, $p = .039$, and when corrected for maternal age, $r = .188$, $p = .034$ (Appendix, Table 9 and 10). There were no other correlations with infant behavioral measures and EFP. At group level however, there were no significant differences between the LowEFP group and the HighEFP group on any episode of the SFP (Appendix, Table 12).

Main Analyses Reactivity

To investigate infant emotional responses to the Still Face Paradigm several 2x2x2 mixed-design Repeated Measures Analyses of Variance (ANOVA) were conducted with maternal emotional regulation problems (ERP; low, high) and maternal executive functioning problems (EFP; low, high) as between-subjects factors and episode of SFP(Play vs. SF2 or SF vs. SF2). First, analyses of comparisons between the play and second minute of the still face episode will be discussed. Second, effects within the still face (comparing SF1 and SF2) are depicted. Only significant main and interaction effects will be discussed.

Play versus Still Face 2. When comparing Play and SF2, there were significant effects of episode for heart rate, positive affect, negative affect and gaze. These effects indicate an increase in heart rate [$M_{Play} = 140.86$, $M_{SF2} = 147.83$, $F(1,128) = 30.51$, $p < .001$, $\eta_p^2 = .19$]; a decrease in positive affect [$M_{SF2} = 2.01$, $M_{SF2} = .397$, $F(1,126) = 246.03$, $p < .001$, $\eta_p^2 = .661$]; an increase in negative affect [$M_{Play} = .71$, $M_{SF2} = 1.03$, $F(1,126) = 7.71$, $p = .006$, $\eta_p^2 = .057$]; and a decrease in infants' gaze [$M_{Play} = 1.60$, $M_{SF2} = 1.03$, $F(1,127) = 42.37$, $p < .001$, $\eta_p^2 = .250$].

There were no significant interaction effects when comparing Play and SF2, nor significant effects for maternal executive functioning problems. However, between-subjects effects were observed for maternal emotion regulation with respect to infant heart rate and arching and squirming behavior. Infants whose mothers had more emotion regulation problems, had on average higher heart rates, than those with mothers with few emotion regulation problems [$M_{HighERP} = 146.66$, $M_{LowERP} = 142.04$, $F(1,128) = 4.79$, $p = .031$, $\eta_p^2 = .04$] (Appendix, Table 13). Moreover, infants of mothers with more regulation problems showed more arching and squirming behavior compared to those with few regulation problems [$M_{HighERP}$ = 1.09, M_{LowERP} = .75, $F(1,127) = 4.78$, $p = .031$, $\eta_p^2 = .036$] (Appendix, Table 14).

Still Face 1 versus Still Face 2. When comparing SF1 and SF2 there was only one main effects of episode, namely an increase in self-soothing behavior [M_{SF1} = .84, M_{SF2} = 1.10, $F(1,127) = 151.70$, $p < .001$, $\eta_p^2 = .544$].

Between-subjects effects were observed for maternal ER and maternal EF with respect to heart rate. Infants of mothers in the HighERP group showed on average higher heart rates, compared to infants of mothers in the LowERP group [$M_{HighERP}$= 150.34, M_{LowERP} = 144.27, $F(1,128) = 6.81$, $p = .010$, $\eta_p^2 = .051$]. In contrast, infants of mothers with higher EFP levels had on average lower heart rates than those of mothers with lower EFP levels [M_{LowEFP} = 149.65, $M_{HighEFP}$ = 144.95, $F(1,128) = 4.08$, $p = .045$, $\eta_p^2 = .031$] (Appendix, Table 15).

There were no group by condition interactions, however there was an interaction effect of ERP and EFP on infant gaze [$F(1,127) = 4.36$, $p = .039$, $\eta_p^2 = .033$] (Appendix, Table 16). This indicates that infants in the LowERP-LowEFP group showed the highest levels of gaze (M = 1.27), compared to infants in the HighERP-HighEFP group (M = 1.15). Infants in the LowERP-HighEFP and HighERP-LowEFP groups had the lowest levels of gaze (M = .97 and M = .91, respectively) see Figure 2.

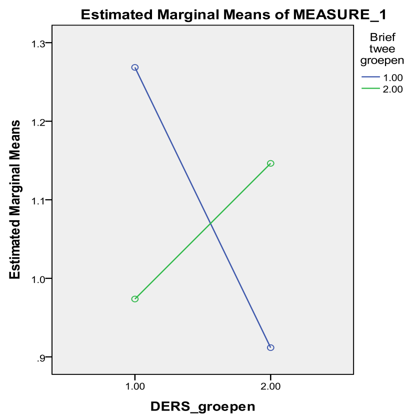

Figure 2. Interaction effect of ERP and EFP on infant gaze (SF1 – SF2).

Main Analyses Regulation

Infant regulation during the Still Face Paradigm was examined by means of several 2x2x2 mixed-design ANOVA's, with maternal emotional regulation problems (ERP; low, high) and maternal executive functioning problems (EFP; low, high) as between-subjects factors and episode of SFP (Play to RE2, SF2 to RE2 and RE1 to RE2) as a within-subjects factor. First, analyses of comparisons between the play and second minute of reunion episode will be discussed. Second, effects comparing the second minute of still face and the second minute of the reunion are presented. Finally, effects within the reunion (comparing RE1 and RE2) are depicted. Only significant main and interaction effects will be discussed.

Play versus Reunion 2. There was a significant main effect of episode on infant heart rate, positive affect, negative affect, gaze and arching and squirming behavior. These results denote an increase in heart rate [M_{Play} = 140.86, M_{RE2} = 147.72, $F(1,128) = 26.29$, $p < .001$, $\eta_p^2 = .036$]; a decrease in positive affect M_{Play} = 2.01, M_{RE2} = 1.29, $F(1,127) = 54.76$, $p < .001$, $\eta_p^2 = .301$]; an increase in negative affect [M_{Play} = .71, M_{RE2} = 1.36, $F(1,127) = 32.29$, $p < .001$, $\eta_p^2 = .203$]; a decrease in gaze [M_{Play} = 1.60, M_{RE2} = 1.35, $F(1,127) = 7.38$, $p = .008$, $\eta_p^2 = .055$]; and a decrease in arching and squirming behavior [M_{Play} = .80, M_{RE2} = .59, $F(1,126) = 4.34$, $p = .039$, $\eta_p^2 = .033$].

In addition, there was an interaction effect of ERP and EFP on infant negative affect [$F(1,127) = 7.54$, $p = .007$, $\eta_p^2 = .056$] (Appendix, Table 17). Meaning that infants in the HighERP-LowEFP group showed the highest levels of negative affect (M = 1.44), followed by infants in the LowERP-HighEFP group (M = 1.08). Infants in the LowERP-LowEFP and HighERP-HighEFP groups had the lowest levels of negative affect (M = .85 and M = .77, respectively), see Figure 4.

Still face 2 versus Reunion 2. Analyses revealed significant effects of episode on infant positive affect, negative affect gaze, self-soothing, and arching and squirming behavior. These effects imply an increase in positive affect [M_{SF2} = .40, M_{RE2} = 1.29, $F(1,126) = 69.16$, $p < .001$, $\eta_p^2 = .354$]; an increase in gaze [M_{SF2} = 1.023, M_{RE2} = 1.35, $F(1,127) = 10.27$, $p = .002$, $\eta_p^2 = .075$]; an increase in self-soothing behavior [M_{SF2} = 1.10, M_{RE2} = .84, $F(1,126) = 4.32$, $p = .040$, $\eta_p^2 = .033$]; a decrease in arching and squirming behavior [M_{SF2} = 1.03, M_{RE2} = .59, $F(1,126) = 15.00$, $p < .001$, $\eta_p^2 = .106$]; an increase in negative affect [M_{SF2} = 1.03, M_{RE2} = 1.36, $F(1,127) = 5.27$, $p = .005$, $\eta_p^2 = .060$].

There were no main effects for ER or EF, neither were there interaction effects for episode and condition. However, similar to play versus reunion 2, there was an interaction effect of ERP and EFP on infant negative affect [$F(1,127) = 6.08$, $p = .015$, $\eta_p^2 = .046$] (Appendix, Table 18). This effect points out that infants in the HighERP-LowEFP group displayed high levels of negative affect (M = 1.65), followed by infants in the LowERP-

HighEFP group (M = 1.21). Infants in the LowERP-LowEFP and HighERP-HighEFP groups showed lower levels of negative affect (M = 1.02 and M = .89, respectively), see Figure 4.

Interestingly, there was a three-way interaction effect of Episode x ERP x EFP on arching and squirming behavior, $F(1,126) = 4.30$, $p = .040$, $\eta_p^2 = .033$ (Appendix, Table 19). As depicted in Table 5 and Figure 3, infants of mothers whose ER and EF problems were congruent, so HighERP-HighEFP and infants in the LowERP-LowEFP groups showed largest decrease in arching and squirming behavior. Infants in the LowERP-HighEFP group had a relatively low level of arching and squirming during still face, and hardly changed these levels to reunion. Infants in the HighERP-LowEFP group however, showed high levels of arching and squirming behavior during still face, and showed little decline to reunion.

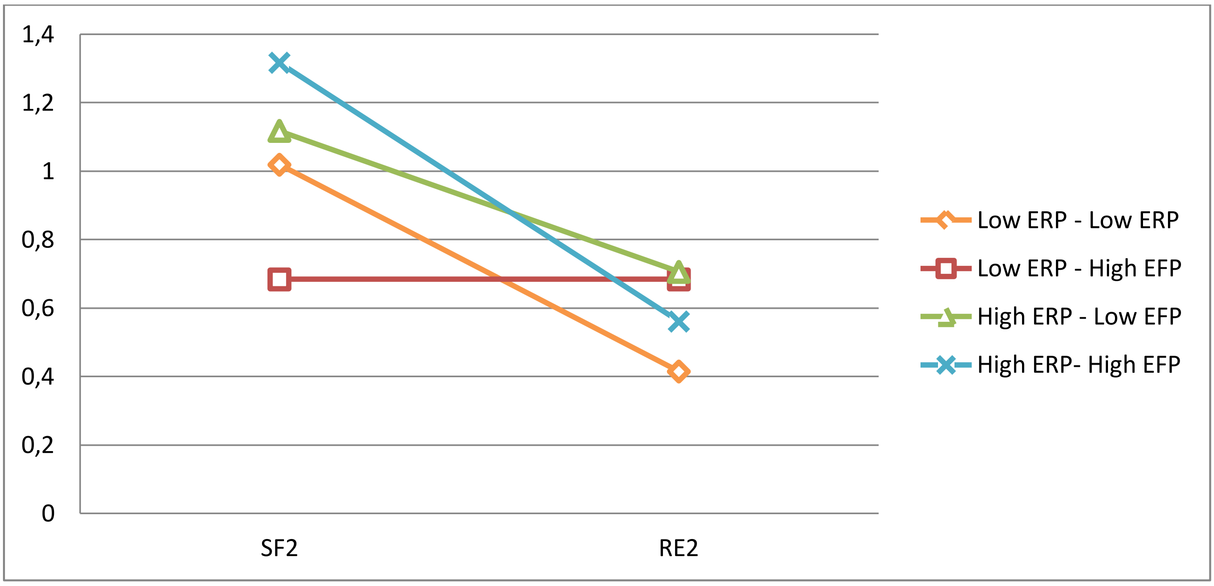

Figure 3. Estimated margins of means for Arching and squirming (SF2- RE2).

Table 5. Estimate means and standard errors for infant arching/squirming (SF2- RE2).

	Still Face 2		Reunion 2	
	M	*SE*	*M*	*SE*
Low ERP - Low ERF	1,019	.149	0,415	.120
Low ERP - High EFP	0,684	0,248	0,684	0,201
High ERP - Low EFP	1,118	0,263	0,706	0,212
High ERP- High EFP	1,317	0,169	0,561	0,137

Reunion 1 versus reunion 2. There was one main effect of episode on infant behavior, namely on positive affect, demonstrating a decrease in positive affect [$M_{RE1} = 1.47$, $M_{RE2} = 1.29$, $F(1,127) = 4.77$, $p = .031$, $\eta_p^2 = .036$].

Again, there were no main effects for ER, EF, nor were there interaction effects for episode and condition, but there was an interaction effect of ERP and EFP on infant negative affect [$F(1,127) = 6.39$, $p = .013$, $\eta_p^2 = .048$] (Appendix, Table 20). Consistent with the other two effects of ER x EF on negative affect, this effect shows that infants in the HighERP-LowEFP group displayed high levels of negative affect ($M = 1.74$), followed by infants in the LowERP-HighEFP group ($M = 1.40$). Infants in the LowERP-LowEFP and HighERP-HighEFP groups showed lower levels of negative affect ($M = 1.07$ and $M = 1.00$, respectively), see Figure 4.

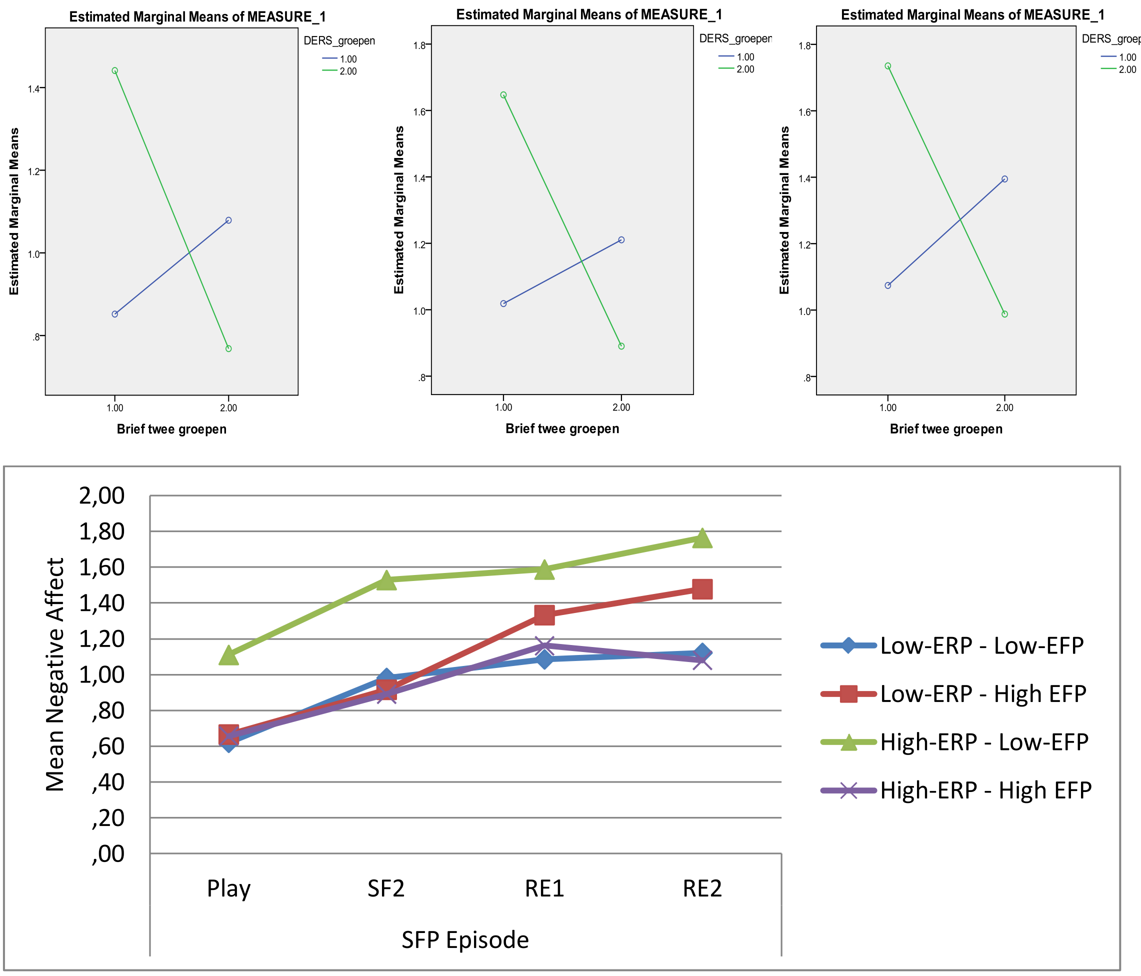

Figure 4. The joint effect ER and EF on infant negative affect.

a) interaction effect for Play versus Reunion 2; b) interaction effect for Still Face 2 versus Reunion 2; c) interaction effect for Reunion 1 versus Reunion 2; d) Display of means by groups (ER and EF) during SFP.

Finally, there was an interaction effect of ERP and EFP on infant arching and squirming behavior [$F(1,126) = 4.49$, $p = .036$, $\eta_p^2 = .034$] (Appendix, Table 21). This indicates that infants in the HighERP-LowEFP group had highest levels of arching and squirming behavior ((*M* = .82), followed by infants from the LowERP-HighEFP group (*M* = .74) and infants from the HighERP-HighEFP group (*M* = .60). Infants in the LowERP-LowEFP group had the lowest levels of arching and squirming behavior (*M* = .38), (Figure 5).

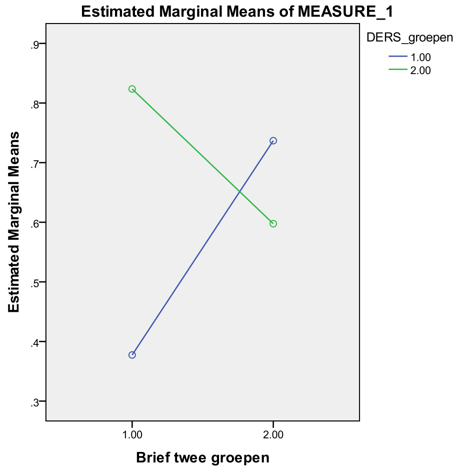

Figure 5. Interaction effect of ERP and EFP on arching/squirming (RE1 - RE2).

Discussion

Poor emotion regulation in early development has been related to negative child outcomes later in life (Cole, Michel, & Teti, 1994; Eisenberg et al., 2010;Hill, Degnan, Calkins, & Keane, 2006; Spinrad, Eisenberg, Gaertner, Popp, & Smith, 2007). Both emotion reactivity and regulation are expected to be influenced by interactions with primary caregivers (Eisenberg, Spinrad, & Eggum, 2010). Mothers' emotion regulation could influence the emotional development of their infant, via the learning paths of observation, parenting practices and emotional family atmosphere (Morris, Silk, Steinberg, Myers, & Robinson, 2007). Mother's self-reported emotion dysregulation has been related to child emotion dysregulation (Morelen, Shaffer, & Suveg, 2014; Kim, Pears, Capaldi, & Owen, 2009). In constrast, better maternal self-regulation has been related to positive parenting practices, as well as more well-regulated emotion in the child (Cumberland-Li, Eisenberg, Champion, Gershoff, & Fabes, 2003). However, the relation between maternal self regulation and emotion regulation in young infants has not been investigated thoroughly. Expansion of the knowledge regarding the role of maternal self regulation on infant emotion regulation, might help to support better emotion regulation in infants, and consecutively decrease negative child outcomes. Therefore the current study intends to investigate infant reactive and regulation emotion responses to the still face paradigm and whether maternal regulation competences influence these responses.

The Effect of the Still Face Paradigm on Infant Reactivity

As hypothesized, infants showed both a physiological and behavioral stress reaction to the still face episode. Coherent with the expectations, infants showed an increase in heart rate as well as an increase in negative affect from the play to the still face episode. Moreover, infants showed a decrease in positive affect and gaze at the mother in reaction to the still face episode. These findings support the classical still face effect, in which infants show stressful behavior during the still face as a result of prolonged disconnection of interaction with their mother (Mesman et al., 2009). There were no changes in heart rate, positive affect, negative affect or gaze within the two minutes of the still face episode. Thus, these physiological and behavioral stress responses follow quickly after initiation of the stressor, and do not change much during the two minutes of stress. However, Ekas, Haltinger and Messinger (2013) did find a decrease of infant gaze, smiling, and social bidding and an increase in cry-face expressions within the 2 minutes of the still face episode. Ekas et al. (2013) coded infant behaviors in slow-motion with a maximum of 30 frames per second, which has enabled them to examine changes in the frequency of each behavior more precisely.

The influence of the SFP on infant self-soothing behavior was different than expected. The level of self-soothing behavior did not increase from play to still face, however there was an increase within the still face episode. This suggests that a longer period of stress and disconnection from the parent has to take place for self-soothing behavior to emerge. Comparison with other studies was impossible, because few have investigated self-soothing behavior, and none have investigated this apart from infant gaze (Tarabulsy et al., 2003).

Finally, in contrast to expectations the SFP did not elicit any effect on infant arching and squirming from play to still face. Unfortunately, this result cannot be compared to other studies either, since other studies examined arching and squirming as a part of a behavioral pattern, often called ‘resistance’ and examined this behavior only during the reunion episode of the SFP (Conradt & Ablow, 2010; Kogan & Carter 1996). Hence, more research is needed to assess specific infant stress responses during the Still Face Paradigm.

Infant Emotional Regulation Responses to the Still Face Paradigm

Infants showed a typical regulation pattern with regard to positive affect and gaze, which increased from the still face to the reunion, but did not return to the baseline levels, a so called ‘carry-over’ effect that is consistent with the literature (Mesman et al., 2009). Interestingly, levels of positive affect also decreased during the reunion. One clarification might be that infants might show a brief instance of positive affect towards the parent once communication is reestablished in order to engage the parent in more communication, but continue to communicate their distress if the parent appears responsive. Further investigation of this pattern during reunion is needed with more precise measures, for example by increasing the frequency of measures during the episode.

In contrast to the hypothesis, but similar to findings of Mesman et al (2009), infants’ negative affect increased from the still face to reunion. Also infants showed an increase in self-soothing behavior from still face to reunion, instead of the expected decrease. In addition, they did not show the expected decrease in heart rate from still face to reunion. Several explanations can be given for these findings. First, the still face episode might have been extremely stressful for the infants, causing infants to linger longer in a state of stress. Second, it appears that for 6-month-old infants the two minutes of the reunion phase is not sufficient to recover entirely from the still face. Moreover, the reunion episode is, even more than the still face episode, a direct representation of the dyadic interaction between mother and infant, and therefore possibly more susceptible for moderation by other factors, such as infant gender and maternal sensitivity, intrusiveness and maternal psychological problems (Haley & Stansbury, 2003; Kogan & Carter, 1996; Weinberg, Olson, Beeghly, & Tronick (2006). Another explanation might be that the current sample is quite a selective sample, other than a representation of the normal population, since mothers were all first time mothers, relatively young, and some dyads experienced high adversities in life. These factors might have contributed to deviations from the expected regulation patterns. Finally, infants might postpone a part of their stress response until their mother becomes available. During the still face, their main goal might be to gain their mother’s attention (fight or flight response). While when the mother becomes responsive again, infants might ‘let go’ of all the stress they have built up during the still face, contributing to more emotional responses during the reunion.

In line with the expectations, infant arching and squirming behavior decreased from still face to reunion. In addition, arching and squirming behavior during the reunion decreased below baseline levels. An explanation for this finding, although speculative, might be that most infants showed initially much resistance against their placement in the car-seat, possibly resulting in fairly high levels of arching and squirming during baseline.

The Effect of Maternal Emotion Regulation Problems on Infant Reactivity

Infants whose mothers had more emotion regulation problems, on average had higher heart rates in reaction to the still face and during the still face. Moreover, they showed more arching and squirming behavior in reaction to the still face, but not during the still face. These findings are in line with the expectations that infants of mothers with more emotion regulation problems show enhanced stress reactivity compared to infants with little emotion regulation problems. Apparently this effect was only present for heart rate and arching and squirming and not for positive affect, negative affect and self-soothing. This may suggest interplay between maternal emotion regulation and the infant sympathetic nervous system, a system responsible for the so called fight or flight response. Ham & Tronick (2006) reported similar findings with regard to their pilot study in which mothers of dysregulated infants were more physiologically anxious or aroused. Maternal physiological anxiety may influence maternal behavior and therefore may hinder the infant to use the mother as an external source of regulation. Complementarily, both mother and infant could have a similar genetic make–up that makes them vulnerable for high emotional reactivity. For example, certain variants of a serotonin transporter gene (such as 5-HTTLPR) or Monoamine oxidase A (MAOA) promoter polymorphisms, both found to be factors involved in inhibition of behavioral and emotional reactions, mood problems, aggression, and antisocial behavior (Propper & Moore, 2006; Zhang, Chen, Den, & Lu, 2014).

The Effect of Maternal Executive Functioning Problems on Infant Reactivity

Since the relation between infant reactivity and maternal executive functioning problems had an explorative character, there are no comparisons with hypotheses or other research. However, a remarkable finding is the association between higher maternal executive functioning problems and lower infant heart rate levels during the still face, which is in the opposite direction from the association with maternal emotion regulation problems. A speculative explanation could be that mothers with few executive functioning problems show very predictable behavior when interacting with their infants normally. Whilst during the SFP, the predictability of mothers' behavior is interrupted, possibly causing a higher physiological stress reaction than in infants who are more used to unpredictable behaviors of their mothers due to more executive functioning problems.

The Joint Effect of Maternal Emotion Regulation and Executive Function Problems

This study was the first to examine the influence of two maternal regulation capacities on infant stress behavior. In the current research the role of maternal executive functioning had an exploratory character. However, the interactions between maternal ER and EF were unexpected. There were interaction effects for several infant behaviors: gaze, negative affect, and arching and squirming. Infants from mothers with few regulation problems (EF and ER) gazed more often at their mothers, than infants from the other groups, during the Still Face episode. The infants from the groups with mixed regulation problems, meaning low problems on one scale, but high on the other, showed the least gaze at their mothers. Low levels of gaze during the still face episode may point to a larger stress reaction to the disconnection of communication between mother and infant. The results also showed an interaction effect of ER and EF problems on infant negative affect when comparing the second minute of the reunion with the play, still face and first minute of reunion episode. Overall it shows that infants whose mothers have high levels of emotion regulation problems, but low levels of executive functioning problems, show more negative affect during the entire stress paradigm. Furthermore, infants in the mixed regulation groups were less able to down-regulate their levels of arching and squirming, as these levels did not decline as much as the groups with both low emotion regulation and executive functioning or both high emotion regulation and executive functioning problem levels.

There are several possible explanations for these findings. The first two are compatible explanations: first, as mothers of these infants were less able to soothe their infant, they might lack strategies to help regulate the emotions of their infant, or they might be emotionally overwhelmed by the stress paradigm themselves and lack emotional control to attend to their infant's needs. A second explanation might be that, the infants were less able to use their mother as external regulation. A third possibility is that the good executive regulation of mothers on one hand, but the worse emotional regulation on the other hand, or the other way around, may contribute to less synchronicity between mother and infant and contribute to an enhanced stress response for the infant during the still face episode. Finally, both emotional regulation and executive functioning were measured by means of self-report, and groups were established based on the means of the total scores. The use of self-report and the absence of a clinical cut-off, might have contributed to a skew image of the latent regulatory capacities of the mothers. Further research should include more specific measurements of regulation capacities, based on observations tasks, and could even make the distinction between hot and cold executive functions.

Limitations

While interpreting the results of the current study, several limitations should be taken into account. The first limitation concerns the measurement of infant heart rate. Heart rate measures are highly vulnerable to body movements, which were not stable throughout the SFP, but differed between infants and SFP episodes.

The second remark involves the sample size. Although the sample size of the entire sample was fairly good (132), the sample sizes of two out of four ER/EF groups were relatively small (18 and 19). Caution is needed when interpreting the results regarding differences between these groups.

Third, maternal emotion regulation and executive functioning were measured by means of self-report. These scores therefore reflect the mother’s own perspective of ER and EF problems in daily life. Moreover, only total scores of these scales were used. Stronger measurement of emotion regulation and executive functioning would entail the use of observation, neuropsychological tasks and the specification of subsets of regulation functions, such as inhibition, cognitive flexibility or even hot and cold executive functioning (Chan, Shum, Toulopoulou, &Chen, 2008). Furthermore, self-reports were obtained during pregnancy, several months before the infant was born. Because pregnancy has been associated with emotional dysregulation (Roos, Robertson, Lochner, Vythilingum, & Stein, 2011) and the influence of pregnancy on executive functions has not been fully established (Onyper, Searleman, Thacher, Maine, Johnson, 2010), these results may not reflect post-partum maternal regulation practices.

Finally, the measurement of infant behavior during the SFP was not fully compatible with measurements used in other studies, making comparison difficult. Moreover, the variables of infant behavior all had a relatively narrow range. The use of smaller time-frames could benefit more precise analyses of behavioral patterns within the SFP, as well as comparisons with other literature.

Future Implications and Conclusion

The project 'MINDS – Leiden' is a longitudinal, prospective study that provides the possibility to study maternal behavior, infant behavior, infant stress response system and the bidirectional relations over time. The current study employed a multimethod approach in which psychological as well as physiological features were considered in order to gain insight into several facets of infant stress responses. Difficulties in emotion regulation at an early stage in life may increase risks for psychological problems later in life (Eisenberg et al., 2010). The current study demonstrated that the SFP was able to elicit physiological and behavioral reaction in 6-month-old infants. The SFP responses included the classical still face effect for heart rate, negative affect, positive affect and gaze, as well as the carry over effect for positive affect and gaze. In addition, maternal emotion regulation problems were associated with increased stress reactions to the still face and less regulation during the reunion episodes, indicating an important role of maternal emotion regulation on infant emotion regulation. Future studies should address pathways of transmission of emotion regulation from mother to infant, such as parenting behaviors or genetic predisposition. Additionally, interactions between maternal factors and infant characteristics, such as temperament, age and gender, should be taken into account to investigate whether effects are similar for all infants. Findings from the present study underline that a mother's capacities to self-regulate, both cognitively and emotionally, can lead to dysregulation of the infant's stress system, thereby putting these infants at risk for future psychopathology. Furthermore, the findings emphasize the need for further investigation of both unique and combined effects of maternal emotion regulation and executive function capacities on infant emotion regulation.

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Appendices

Table 6. Correlation table infant heart rate, ERP and EFP, controlled for maternal age.

	Baseline	Play	Still Face 1	Still Face 2	Reunion 1	Reunion 2	Recovery
Play	.621**						
Still Face 1	.528**	.741**					
Still Face 2	.473**	.493**	.742**				
Reunion 1	.478**	.547**	.703**	.825**			
Reunion 2	.432**	.559**	.555**	.504**	.708**		
Recovery	.592**	.707**	.762**	.680**	.684**	.621**	
ERP	.118	.035	.063	.068	.092	.027	.049
EFP	.103	-.015	-.077	-.001	.032	-.029	-.033

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 7. Independent samples T-test on Heart Rate, by groups (LowERP and HighERP), all equal variances assumed.

	Low ERP (*N* = 73)		High ERP (*N* = 59)				
	M	*SD*	*M*	*SD*	*T*	*df*	*p*
Baseline	133.99	13.00	136.13	12.72	-.951	130	.343
Play	139.48	11.57	142.59	11.74	-1.525	130	.130
Still Face 1	144.19*	12.23	148.83*	12.41	-2.154	130	.033
Still Face 2	145.83	13.72	149.38	13.47	-1.491	130	.138
Reunion 1	145.76	15.64	149.22	14.36	-1.312	130	.192
Reunion 2	146.40	16.70	148.07	16.08	-.581	130	.562
Recovery	142.43	10.45	145.17	9.34	-1.566	130	.120

*Significant difference.

Table 8. Independent samples T-test on Heart Rate, by groups (LowEFP and HighEFP), all equal variances assumed.

	Low EFP (*N* = 72)		High EFP (*N* = 60)				
	M	*SD*	*M*	*SD*	*T*	*df*	*p*
Baseline	133.74	12.45	136.40	13.31	-1.185	130	.238
Play	141.13	12.11	140.56	11.29	.274	130	.784
Still Face 1	147.41	13.54	144.89	11.03	1.160	130	.248
Still Face 2	148.05	13.14	146.65	14.37	.584	130	.560
Reunion 1	147.77	14.44	146.75	16.01	.382	130	.703
Reunion 2	148.12	16.60	145.96	16.19	.753	130	.453
Recovery	143.84	10.51	143.44	9.50	.227	130	.821

Table 9. Correlations for Reactivity behavior, ERP and EFP, corrected for maternal age

	Positive Affect					Negative Affect				
	Play	SF1	SF2	RE1	RE2	Play	SF1	SF2	RE1	RE2
Positive Affect										
Still Face 1	.380**									
Still Face 2	.308**	.500**								
Reunion 1	.444**	.333**	.495**							
Reunion 2	.536**	.397**	.347**	.696*						
Negative Affect										
Play	-.234**	-.167	-.140	-.160	-.118					
Still Face 1	-.124	-.161	-.158	-.329**	-.268**	.537**				
Still Face 2	.023	-.138	-.263**	-.312**	-.188*	.389**	.727**			
Reunion 1	-.102	-.172	-.247**	-.442**	-.384**	.381**	.628**	.739**		
Reunion 2	-.230**	-.243*	-.219*	-.417**	-.572**	.377**	.569**	.470**	.719**	
ERP	-.092	-.009	-.013	.021	-.095	.016	.030	.068	.083	.055
EFP	-.130	.046	-.071	.009	-.052	.013	-.073	-.021	-.015	-.020

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 10. Correlations for Regulation measures, ERP and EFP, corrected for maternal age.

	Gaze					Self Soothing					Arching and Squirming				
	Play	SF1	SF2	RE1	RE2	Play	SF1	SF2	RE1	RE2	Play	SF1	SF2	RE1	RE2
Gaze															
Still Face 1	.384**														
Still Face 2	.287**	.584**													
Reunion 1	.264**	.401**	.422**												
Reunion 2	.355**	.259**	.236**	.623**											
Self Soothing															
Play	-.162	-.031	-.020	-.098	-.102										
Still Face 1	-.012	-.098	-.045	-.045	.020	.283**									
Still Face 2	-.126	-.148	-.057	.012	-.004	.175*	.570**								
Reunion 1	-.021	.100	.005	.026	-.010	.349**	.317**	.341**							
Reunion 2	.029	.069	-.004	-.020	-.086	.170	.174*	.352**	.487**						
Arching/squirming															
Play	-.205*	-.038	-.041	-.038	-.041	.054	.004	-.023	.030	-.128					
Still Face 1	-.012	-.084	-.188*	-.072	.029	-.157	-.096	-.046	-.066	-.094	.306**				
Still Face 2	.009	-.011	-.183*	-.051	.013	-.090	-.073	-.097	-.058	-.108	.225*	.678**			
Reunion 1	-.132	-.089	-.144	-.203*	-.151	-.047	-.050	-.046	-.075	-.046	.362**	.284**	.364**		
Reunion 2	-.245**	-.181*	-.196*	-.104	-.127	-.138	.061	.070	-.185*	-.135	.394**	.362**	.297**	.464**	
ERP	.025	-.054	-.065	-.077	-.019	-.163	-.130	-.050	-.035	.032	.084	.091	.145	.137	.147
EFP	.061	.018	-.041	-.152	-.047	-.111	-.151	-.092	-.049	-.026	.078	.030	.075	.188*	.161

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 11. T-test on infant behavior, by groups(Low and HighERP), equal variances assumed.

	LowERP (*N* = 73*)		HighERP (*N* = 59*)				
	M	*SD*	*M*	*SD*	*T*	*df*	*p*
Positive Affect							
Play	2.11	.980	1.97	.999	.829	130	.409
Still Face 1	.41	.684	.47	.681	-.454	129	.650
Still Face 2	.42	.687	.43	.775	-.112	128	.911
Reunion 1	1.49	1.082	1.57	1.061	-.402	129	.689
Reunion 2	1.34	1.121	1.41	1.077	-.368	129	.713
Negative Affect							
Play	.59	.831	.75	.939	-1.016	130	.311
Still Face 1	.86	1.032	1.02	1.068	-.837	129	.404
Still Face 2	.90	1.169	1.02	1.147	-.555	129	.580
Reunion 1	1.08	1.211	1.21	1.166	-.595	129	.553
Reunion 2	1.23	1.161	1.21	1.181	.126	129	.900
Gaze							
Play	1.64	.770	1.56	.749	.634	130	.527
Still Face 1	1.25	.722	1.14	.712	.861	129	.391
Still Face 2	1.14	.732	1.02	.761	.914	129	.363
Reunion 1	1.47	.728	1.38	.813	.641	129	.523
Reunion 2	1.41	.910	1.40	.877	.091	129	.927
Self Soothing							
Play	1.11	1.087	.83	.950	1.550	130	.123
Still Face 1	.88	1.130	.71	1.155	.846	129	.399
Still Face 2	1.04	1.252	.97	1.154	.355	129	.723
Reunion 1**	.72	.996	.59	.773	.876	127.842	.382
Reunion 2	.82	.998	.81	1.051	.050	128	.960
Arching/ squirming							
Play	.66	.885	.93	1.081	-1.605	130	.111
Still Face 1	.96	.964	1.05	.963	-.548	129	.585
Still Face 2	.95	1.092	1.26	1.069	-1.647	129	.102
Reunion 1	.46	.730	.72	.854	-1.912	128	.058
Reunion 2	.49	.839	.60	.917	-.761	128	.448

* For three infants not all episodes of the SFP could be coded because the camera view was blocked.

**Equal variances not assumed.

Table 12. Independent samples T-test on infant behavioral measures, by groups (LowEFP and HighEFP), equal variances assumed.

	LowEFP (*N* = 72*)		HighEFP (*N* = 60)				
	M	*SD*	*M*	*SD*	*T*	*df*	*p*
Positive Affect							
Play	2.15	.929	1.92	1.046	1.373	130	.172
Still Face 1	.41	.688	.47	.676	-.486	129	.627
Still Face 2	.49	.737	.35	.709	1.065	128	.289
Reunion 1	1.51	1.054	1.55	1.096	-.228	129	.820
Reunion 2	1.34	1.055	1.42	1.154	-.407	129	.685
Negative Affect							
Play	.71	.911	.60	.848	.702	130	.484
Still Face 1**	1.03	1.171	.82	.873	1.182	127.131	.239
Still Face 2**	1.04	1.270	.85	1.005	.967	128.488	.336
Reunion 1	1.17	1.253	1.10	1.115	.330	129	.742
Reunion 2	1.30	1.188	1.13	1.142	.794	129	.429
Gaze							
Play	1.56	.748	1.67	.774	-.836	130	.405
Still Face 1	1.21	.715	1.18	.725	.221	129	.825
Still Face 2	1.15	.710	1.00	.781	1.188	129	.237
Reunion 1	1.51	.734	1.33	.795	1.298	129	.196
Reunion 2	1.45	.907	1.35	.880	.642	129	.522
Self Soothing							
Play	1.07	1.066	.88	.993	1.030	130	.305
Still Face 1	.87	1.133	.72	1.151	.782	129	.435
Still Face 2	1.06	1.241	.95	1.171	.501	129	.617
Reunion 1	.67	.944	.65	.860	.134	128	.893
Reunion 2	.79	1.034	.85	1.005	-.358	128	.721
Arching/ Squirming							
Play	.82	.998	.73	.972	.500	130	.618
Still Face 1	1.00	.971	1.00	.957	.000	129	1.000
Still Face 2	1.06	1.054	1.12	1.136	-.315	129	.753
Reunion 1	.49	.756	.68	.833	-1.417	128	.159
Reunion 2	.49	.830	.60	.924	-.743	128	.459

* For three infants not all episodes of the SFP could be coded because the camera view was blocked.

**Equal variances not assumed.

Table 13. Repeated measures of ANOVA Episode (Play, SF2) x ERP x EFP on infant heart rate.

	SS	*df*	*MS*	*F*	*P*	η_p^2
Tests of Within-Subjects Effects						
Episode	2569.96	1.00	2569.96	30.15	.000*	.19
Episode * ERP	12.10	1.00	12.10	.14	.707	.00
Episode * EFP	25.31	1.00	25.31	.30	.587	.00
Episode * ERP* EFP	51.90	1.00	51.90	.61	.437	.00
Error (Episode)	10910.24	128.00	85.24			
Tests of Between-Subjects Effects						
Intercept	4412779.04	1.00	4412779.04	18670.09	.000	.99
ERP	1131.07	1.00	1131.07	4.79	.031*	.04
EFP	480.74	1.00	480.74	2.03	.156	.02
ERP * EFP	10.18	1.00	10.18	.04	.836	.00
Error	30253.51	128.00	236.36			

Table 14. Repeated measures of ANOVA Episode (Play, SF2) x ERP x EFP on infant arching and squirming.

	SS	*df*	*MS*	*F*	*p*	η_p^2
Tests of Within-Subjects Effects						
Episode	3.04	1.00	3.04	3.67	.057	.028
Episode * ERP	.01	1.00	.01	.01	.913	.000
Episode * EFP	.23	1.00	.23	.28	.600	.002
Episode * ERP* EFP	1.86	1.00	1.86	2.25	.136	.017
Error (Episode)	105.17	127.00	.83			
Tests of Between-Subjects Effects						
Intercept	174.63	1.00	174.63	136.92	.000	.519
ERP	6.10	1.00	6.10	4.78	.031*	.036
EFP	1.06	1.00	1.06	.83	.363	.007
ERP * EFP	.39	1.00	.39	.30	.583	.002
Error	161.98	127.00	1.28			

Table 15. Repeated measures of ANOVA Episode (SF1, SF2) x ERP x EFP on infant heart rate.

	SS	*df*	*MS*	*F*	*P*	η_p^2
Tests of Within-Subjects Effects						
Episode	59.29	1.00	59.29	1.31	.255	.010
Episode * ERP	49.72	1.00	49.72	1.10	.297	.008
Episode * EFP	52.49	1.00	52.49	1.16	.284	.009
Episode * ERP* EFP	1.66	1.00	1.66	.04	.849	.000
Error (Episode)	5810.52	128.00	45.39			
Tests of Between-Subjects Effects						
Intercept	4595262.97	1.00	4595262.97	16043.32	.000	.992
ERP	1950.14	1.00	1950.14	6.81	.010*	.051
EFP	1169.71	1.00	1169.71	4.08	.045*	.031
ERP * EFP	136.51	1.00	136.51	.48	.491	.004
Error	36662.83	128.00	286.43			

Table 16. Repeated measures of ANOVA Episode (SF1, SF2) x ERP x EFP on infant gaze.

	SS	*df*	*MS*	*F*	*p*	η_p^2
Tests of Within-Subjects Effects						
Episode	.48	1.00	.48	2.18	.142	.017
Episode * ERP	.04	1.00	.04	.19	.664	.001
Episode * EFP	.33	1.00	.33	1.49	.225	.012
Episode * ERP* EFP	.12	1.00	.12	.52	.473	.004
Error (Episode)	28.22	127.00	.22			
Tests of Between-Subjects Effects						
Intercept	239.60	1.00	239.60	287.97	.000	.694
ERP	.44	1.00	.44	.53	.469	.004
EFP	.05	1.00	.05	.06	.812	.000
ERP * EFP	3.63	1.00	3.63	4.36	.039*	.033
Error	105.67	127.00	.83			

Table 17. Repeated measures of ANOVA (Episode (Play, RE2) x ERP x EFP) on infant Negative Affect.

	SS	*df*	*MS*	*F*	*p*	η_p^2
Tests of Within-Subjects Effects						
Episode	21.57	1.00	21.57	32.29	.000*	.203
Episode * ERP	.33	1.00	.33	.50	.483	.004
Episode * EFP	.01	1.00	.01	.02	.896	.000
Episode * ERP* EFP	1.76	1.00	1.76	2.64	.107	.020
Error (Episode)	84.85	127.00	.67			
Tests of Between-Subjects Effects						
Intercept	222.10	1.00	222.10	159.47	.000	.557
ERP	1.01	1.00	1.01	.72	.397	.006
EFP	2.57	1.00	2.57	1.85	.176	.014
ERP * EFP	10.49	1.00	10.49	7.54	.007*	.056
Error	176.87	127.00	1.39			

Table 18. Repeated measures of ANOVA (Episode (SF2, RE2) x ERP x EFP) on infant Negative Affect.

	SS	*df*	*MS*	*F*	*p*	η_p^2
Tests of Within-Subjects Effects						
Episode	5.72	1.00	5.72	8.07	.005*	.060
Episode * ERP	.47	1.00	.47	.66	.419	.005
Episode * EFP	.10	1.00	.10	.15	.704	.001
Episode * ERP* EFP	1.33	1.00	1.33	1.87	.173	.015
Error (Episode)	90.01	127.00	.71			
Tests of Between-Subjects Effects						
Intercept	294.34	1.00	294.34	153.48	.000	.547
ERP	1.23	1.00	1.23	.64	.424	.005
EFP	4.13	1.00	4.13	2.16	.145	.017
ERP * EFP	11.66	1.00	11.66	6.08	.015*	.046
Error	243.56	127.00	1.92			

Table 19. Repeated measures of ANOVA (Episode (SF2, RE2) x ERP x EFP) on infant Arching and squirming.

	SS	*df*	*MS*	*F*	*p*	η_p^2
Tests of Within-Subjects Effects						
Episode	10.14	1.00	10.14	15.00	.000*	.106
Episode * ERP	1.03	1.00	1.03	1.52	.220	.012
Episode * EFP	.22	1.00	.22	.32	.572	.003
Episode * ERP* EFP	2.91	1.00	2.91	4.30	.040*	.033
Error (Episode)	85.18	126.00	.68			
Tests of Between-Subjects Effects						
Intercept	136.71	1.00	136.71	108.23	.000	.462
ERP	2.61	1.00	2.61	2.07	.153	.016
EFP	.00	1.00	.00	.00	.986	.000
ERP * EFP	.05	1.00	.05	.04	.848	.000
Error	159.15	126.00	1.26			

Table 20. Repeated measures of ANOVA (Episode (RE1, RE2) x ERP x EFP) on infant Negative Affect.

	SS	*df*	*MS*	*F*	*p*	η_p^2
Tests of Within-Subjects Effects						
Episode	.74	1.00	.74	1.91	.169	.015
Episode * ERP	.24	1.00	.24	.61	.434	.005
Episode * EFP	.03	1.00	.03	.08	.778	.001
Episode * ERP* EFP	.52	1.00	.52	1.35	.247	.011
Error (Episode)	49.13	127.00	.39			
Tests of Between-Subjects Effects						
Intercept	349.25	1.00	349.25	151.08	.000	.543
ERP	.84	1.00	.84	.36	.548	.003
EFP	2.36	1.00	2.36	1.02	.314	.008
ERP * EFP	14.78	1.00	14.78	6.39	.013*	.048
Error	293.59	127.00	2.31			

Table 21. Repeated measures of ANOVA (Episode (RE1, RE2) x ERP x EFP) on infant Arching and squirming.

	SS	*df*	*MS*	*F*	*p*	η_p^2
Tests of Within-Subjects Effects						
Episode	.37	1.00	.37	.98	.325	.008
Episode * ERP	.25	1.00	.25	.66	.417	.005
Episode * EFP	.00	1.00	.00	.00	.957	.000
Episode * ERP* EFP	.38	1.00	.38	1.00	.318	.008
Error (Episode)	47.66	126.00	.38			
Tests of Between-Subjects Effects						
Intercept	83.09	1.00	83.09	84.14	.000	.400
ERP	1.22	1.00	1.22	1.23	.269	.010
EFP	.23	1.00	.23	.23	.630	.002
ERP * EFP	4.43	1.00	4.43	4.49	.036*	.034
Error	124.43	126.00	.99			