

The Effects of Maternal Depression on Maternal Behavior and Infant's Emotion Regulation  
during the Still-Face Paradigm

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### **Abstract**

This study investigated the effect of maternal depression on mother and infant behavior during the Still Face Paradigm (SFP). It was investigated whether the SFP elicited the still-face effect. In addition, the effect of maternal depression on infant's emotion regulation and maternal behavior during the SFP was examined. Fifty-two mother-infant dyads participated in this study. Maternal depression was measured using a positive score on either the MINI-International Neuropsychiatric Interview (MINI-Plus) or Beck Depression Inventory-II (BDI-II) during the first or second appointment. Additionally, the cognitive development of six-month old infants was measured using the Bayley Scales of Infant Development (BSID-II). During a home-visit, the SFP was administered by trained PhD- or graduate students, and mother and infant behaviors were coded afterwards. Results indicated that the still face effect was found for negative affect, arching and/or squirming behavior, gaze toward mother, and additionally for maternal sensitivity and maternal positive affect. Infants of depressed mothers averted gaze during all episodes of the SFP compared to infants of non-depressed mothers. Combination of SFP episodes and maternal depression resulted in more arching and/or squirming behavior during the play and reunion episodes for infants of depressed mothers. Furthermore, mothers who feel depressed showed more internalizing or helpless behavior during the reunion. The findings of this study increase the knowledge of the effects of maternal depression on mother behavior and infant's regulatory capacities during stress exposure.

*Keywords:* still-face paradigm, maternal depression, arching and/or squirming behavior, gaze, maternal sensitivity, maternal positive affect, infant cognitive development

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Maternal and offspring (mental) health along with a good future life trajectory cannot be taken for granted. Several factors with an adverse impact on maternal and child (mental) health and their development have been identified (Olds, Sadler, & Kitzman, 2007).

Childhood aggression is one of those factors that has been identified, however childhood aggression itself is also problematic. Campbell, Spieker, Burchinal, & Peo (2006) reported that aggression across childhood influences children's later adjustment, such as poorer social skills, higher levels of externalizing behavior, elevated levels of ADHD symptoms, and more self-reported peer problems. Moreover, when antisocial behavior forms a pattern in daily life it could lead to diagnoses of conduct disorder (CD) or oppositional defiant disorder (ODD). Furthermore, since these disorders are difficult to overcome with therapy (van Goozen, Fairchild, & Harold, 2006), it is recommended to screen early for - and preferably prevent - the development of these aggressive disorders in toddler- and childhood in order to reduce adverse outcomes.

Other adverse factors are parental or environmental factors, such as early pregnancy, low income, low education level, and smoking during pregnancy, as well as child factors, such as delayed or impaired cognitive and emotion regulation skills (Olds et al., 2007). A number of these factors have been targeted in prevention and intervention programs and some of them could be influenced to such an extent that beneficial effects were observed regarding children's behavioral development and parents' wellbeing (Olds, 2006).

The aim of the project 'A Good Start' is to prevent maternal health problems and improve children's life-course by improving maternal behavior and environmental conditions using a home visiting program during pregnancy and early life of the infant. Assessment of

behavioral and emotional problems of both mother and infant can help determining early markers for psychopathology. Therefore, one of the aims of this project is to study associations between maternal mental health problems and their behavior. Also, the impact of maternal health problems on infant regulatory capacities during stress exposure is studied.

### **Influence of maternal depression on maternal behavior**

In preventive interventions to improve children's health and behavioral adaptation, parenting seems to be a successful target (Olds, et al., 2007). Although mother's earlier experiences, genetic makeup, and other barriers can affect the success of these interventions, it also affects the care mothers give to their infants (Olds, et al., 2007). Maternal depression can reduce mothers' ability to care for her infant; subsequently, children may develop behavioral or emotional problems (Hay, Pawlby, Angold, Harold, and Sharp, 2003; Newberger & White (1990, as cited in Olds, 2006). In contrast, mothers who are able to sensitively read and respond to their babies' signals are more likely to read their children's needs and developmental competencies, improving their understanding of the infant and reducing the unintentional damages (Peterson & Gable, 1998, as cited in Olds, 2006).

Defining the exact associations between maternal depression, maternal behavior, and outcome of the child is difficult, because all these factors are subject to change over time. According to Lovejoy, Graczyk, O'Hare, and Neuman et al. (2000) maternal depression tends to lead to an overall reduction in maternal behavior, such as sensitivity and positive affect. Studies show that depressed mothers have less positive interactions with their infants. Azak and Raeder (2013) found lower quality in maternal behavior at six months when depressed mothers were compared with non-depressed mothers. They seem to be less sensitive, more withdrawn, and more self-occupied (Field, 1984; Cohn, Campbell, Matias, & Hopkins, 1990; Field, Healy, Goldstein, & Guthertz, 1990).

Results of Pawlby et al. (2010) suggest that mothers who feel depressed show more intrusive behavior toward their infants compared to healthy mothers. In addition, they are less likely to comment appropriately on their infants' mental states and they also tend to seek more attention toward their infant compared to healthy mothers (Rosenblum, McDonough, Sameroff, & Muzik, 2008). Results indicate that highly intrusive mothers show more negative affect during a stressful situation, measured by the still-face episode (Kogan and Carter, 1996). Maternal intrusiveness can be seen as a mismatch in the interaction and can be defined as interfering behavior; wherein mothers disregard their infants' autonomy (Ipsa et al., 2004). A highly intrusive mother does whatever she feels like doing, overwhelms her infant with excessive stimulation or changes the course of the infant's own activities. Instead of gentle guidance, mothers can use rough behavior that dominates an infant's play. Kogan and Carter (1996) found that infants looked less during the reunion episode in consequence of maternal intrusiveness.

Due to their less responsive and more emotionally unavailable behavior mothers, who are feeling depressed, infants can experience behavioral disorganization. Repairing the mismatch in interaction between them and their infants and returning to a matched state with reciprocal exchange seem to be more difficult for depressed mothers (Cohn & Tronick & 1989; Jameson, Gelfand, Kulcsar, & Teti (1997). In addition, factors that reduce maternal sensitivity increase the frequency of mismatches during interaction (Gunning, Halligan, & Murray, 2013). Furthermore, an infant's experience in coping with these mismatches results in development of self-regulatory skills (Egeland, Pianta, & O'Brien, 1993). When the mismatches within the mother-infant dyad are not solved properly, the infant cannot develop these self-regulatory skills adequately. Therefore, maternal sensitivity is an important factor in regulating infants' emotions. Maternal sensitivity during the play episode is related to better infant regulation (Kogan and Carter, 1996).

### **Influence of maternal depression on infants' cognitive development**

Less positive interactions between depressed mother-infant dyads can negatively influence the infant's cognitive development. However, study results on the effects of maternal depression on child's cognitive performance are inconsistent. Some studies find a relation between maternal depression and a decreased cognitive functioning (Hay et al., 2001; Deave, Heron, Evans, & Emond, 2008; Brand & Brennan, 2009; Azak, 2012), whereas others only find a relation under specific conditions, e.g. when the mothers were poorly educated (Gunning et al., 2013), or with longer duration of the depression (Lovejoy et al., 2000). In contrast, Hay et al. (2001) found long lasting results on cognitive development, even when the postnatal depression was brief. Azak (2012) found that infants of depressed mothers had lower global cognitive performance than infants of non-depressed mothers. Their cognitive performance was measured by their visual perception, fine motor control, receptive and expressive language. In addition, results of Bornstein, Mash, and Arterberry (2012) indicate that infants of depressed mothers are less able to discriminate between novel and familiar views of demonstrated objects. As mothers with a depression are incongruent in their interactions with their babies and are more withdrawn, they probably stimulate their infants' development less compared to non-depressed mothers. This can play a role in infant emotion regulation during the Still Face Paradigm (SFP).

### **Still-Face Paradigm**

Behavioral responses and emotion regulation of both mother and infant during stress exposure can be measured using the Still Face Paradigm (SFP). The SFP measures face-to-face interactions between mother and infant during three different episodes: (1) a play episode, observing the normal interaction at baseline, (2) a still-face episode, in which mother becomes unresponsive and shows an expressionless face, and (3) a reunion episode, in which mother resumes normal interaction. During the still-face episode, infants experience maternal

behavior that is mostly incongruent with their mothers' expected behavior; instead of interacting with their infant, they become silent and are not allowed to touch their infant. This causes the classic still-face effect on infants. Apparently, during the first months of life infants have already formed a pattern of expectations within mother-infant interactions (Mesman, van IJzendoorn, & Bakermans-Kranenburg, 2009). Thereby the SFP will result in behaviorally and physically stressful situations for infants (Gunning et al., 2013), due to the infant's mismatch in expectations. Field (1995) argues that an infant needs help, for example of a parent, to regulate their emotions to achieve optimal arousal levels. When the infant recovers from its mismatch, the interaction between mother and infant probably facilitates the development of infant self-regulatory capacities (Tronick, Als, Adamson, Wise, & Brazelton, 1978; Gunning et al., 2013). However, during the still-face the infant is left to regulate its own emotions, resulting in increased negative affect and decreased gaze behavior due to limited skills to regulate their emotions (Mesman et al., 2009). Incongruent interactions between mothers and infants result in various responses. According to Mesman et al. (2009), most SFP studies showed a decrease in infants' gaze toward mothers, in addition to an increase in negative affect. A certain 'carry-over' effect, between the play and reunion episode, was also found; infants maintain a raised level of negative affect during the recovery (Mesman et al., 2009).

### **Current study and hypotheses**

In the current study, these possible adverse effects of maternal depression on maternal behavior, infant emotion regulation, and infant cognitive development were investigated. The effect of the SFP on maternal and infant behavior was examined. Due to incongruent interactions during the SFP, it was expected that infants show a classic still-face effect wherein they showed less emotion regulation during the still-face episode. This effect was expected to carry over to the reunion episode. Furthermore, it was predicted that maternal

depression would lead to less sensitive and more intrusive behavior of the mother during the SFP. It was also expected that infants of depressed mothers would be less able to regulate their emotions during the SFP and that they would have a lower cognitive development at six months compared to non-depressed mothers. More exploratory was examined whether the effects of maternal depression on infant emotion regulation during the SFP could be affected by the infant's cognitive development.

Therefore, the following research questions were investigated:

- Is there a classic still-face effect for infant and maternal behavior?
- What is the effect of maternal depression on maternal behavior in contact with her infant?
- What is the effect of maternal depression on infant behavior during the SFP?
- Does maternal depression lower the cognitive development of infants?
- Does the cognitive development of infants affect the effect of maternal depression on infant and maternal behavior during the SFP?

## **Method**

### **Study background**

This study is part of a larger study, a randomized control trial (RCT), aiming to include 180 mothers and their babies; 60 mothers who will be assigned to the high-risk (HR) group and receiving an intervention, 60 mothers who will be assigned to the HR-group and who will not receive an intervention, and 60 mothers who will be assigned to the control (low-risk, LR) group. HR-mothers were randomly assigned to the group receiving the intervention. Mothers between 17 and 25 years old, who never had a previous live birth, and who had good knowledge of the Dutch language were eligible to participate in this study. Preferably, the included mothers are maximally 27 weeks pregnant, in order to schedule their first appointment at 27 weeks. Mothers were assigned to the risk group based on their (lack of)



self-sufficiency, and minimally one of the following risk factors had to be present: unemployed, living in poverty or having financial problems, housing problems, restricted or inadequate social support system, single or varying partners, psychopathology (e.g. depression- and anxiety complaints, borderline problematic, and aggression), and drug (ab)use, (e.g. smoking, alcohol or drugs) (Overpeck, Brenner, Trumble, Trifiletti, & Berendes, 1998; Moffitt and Caspi, 2001). Mothers with heavy drug abuse, serious (diagnosed) psychopathology, such as psychosis or schizophrenia, were excluded from this study, as were mothers with a mental disability ( $IQ < 70$ ), serious medical issues, or when during pregnancy it became known that the unborn baby would have a serious disability with a prognosis that is divergent from normal development (e.g. genetic disease or syndrome). Mothers receiving the intervention were supported by their individual coach. The intervention is based on ‘Minding the baby (MTB): a Reflective Parenting Program’ of the Yale Child Study Center and Yale School of Nursing (Slade et al., 2005). The program’s aim is to improve the physical and mental health of mother and child, mother’s social support (network), the development of the child, and specifically, to improve the reflective functioning of the mother. Participants were recruited via health centers, baby clinics, home practitioners, nurses, and a pregnancy fair.

### **Participants**

Participants were 52 mothers with their first-born children (28 boys, 24 girls), who took part in a longitudinal study since their pregnancy. Mean age of the mothers was 22 years ( $SD = 2.52$ , range 16-26 years), and 64% were caucasian. Forty-eight percent of the mothers had a paid job, their mean monthly income was 2531 euros ( $SD = 1245$ ), and 77% of the mothers only had their high school degree. Five percent of the mothers lived alone, 55% of the mothers lived with their partner, and 40% of the mothers lived with other family members or friends. The mean birth weight of the infants was 3354 grams ( $SD = 515.7$ ) and 9% of them were born pre-term. In the current study, 56% of the mothers were assigned to the

control group, 23% of the mothers were assigned to the HR-group without intervention, and 22% of the mothers were assigned to the HR-group with intervention. However, due to the number of mothers targeted for this study, mothers at risk and non-risk were considered as one group, leading to a various population.

### **Procedure**

The mothers were visited by two researchers two times at home; once during pregnancy around 27 weeks and once when the child was six months old. These researchers were either PhD students or graduate students. During the first appointment the researchers came in contact with the mothers, who were asked to complete several questionnaires.

The second appointment was scheduled at their home within three weeks of the infant's six-month birthday. Both researchers led parts of the visit, one explained the tasks to the mother, whereas the other prepared the different materials and settings, took notes of time, and of maternal and infant behaviors that possibly violated task rules. Visits included a developmental assessment of the infant (e.g. BSID-II and SFP). In addition, mothers were asked to complete a series of questionnaires. To reduce the time of visit mothers were sent questionnaires prior to the visits. All researchers had received training in home observations. After the second visit, videotapes were coded for the infant's cognitive development and infant's emotion regulation by graduate students, who were preferably others than those present during the home visit.

Mothers received a €10 and €20 gift certificate, respectively, for completing the first and second assessments. The infant also received a small present after completing the second measure.

This study is financed by the The Netherlands Organisation for Scientific Research (NWO)'s National Initiative: Brain & Cognition. The ethics review board of the Institute of

Education and Child Studies approved the study protocol, as did the Medical Ethics Committee of Leiden University Medical Center (LUMC).

### Measures

**Maternal depression.** Depression was measured using the MINI-International Neuropsychiatric Interview (MINI-Plus) (Vliet, Leroy, and Megen; 2000) during the first appointment ( $n = 23$ ), and the Beck Depression Inventory-II (BDI-II) (Does, 2002) during the first ( $n = 7$ ) and second appointment ( $n = 10$ ). In this study, due to a small sample size, the depression variable was composed of the scores on these three instruments. Once mothers indicated that they felt depressed in the past or during assessments, either on the MINI-Plus or the BDI-II, they were classified as depressed in this study. Others were classified as non-depressed. This resulted in 23 non-depressed mothers and 29 depressed mothers, of which two mothers were classified as depressed on all measurements.

**BDI-II.** The BDI-II is a 21-item self-report depression inventory that can be used to assess the symptoms and the level of depression in adults and adolescents from 13 to 80 years of age (Dozois, 2010). Respondents were requested to indicate which of the four statements, best described their feelings during the past two weeks, including day of assessment.

Items are rated on a 4-point (0 to 3) scale and a total score was obtained by summing the ratings for all items, resulting in possible scores ranging from 0 to 63. Scores ranging between 0 and 13 are considered to reflect a minimal level of depression; scores between 14 to 63 are labeled as a higher level of depression. The BDI-II does not provide a psychiatric diagnosis.

The reliability and validity of the BDI-II are considered to be satisfactory (Osman, Barrios, Gutierrez, Williams, & Bailey, 2008); the BDI-II has a high internal consistency with an average of .92 (Osman et al., 2008; Dozois, 2010).

**Mini-Plus.** The MINI-Plus is a structured diagnostic interview, which is developed to assess psychiatric diagnoses according to DSM-IV and ICD-10 criteria. The MINI-Plus includes 23 disorders, such as somatization disorders, conduct disorder, attention-deficit/hyperactivity disorders, and mixed anxiety-depressive disorders.

For each disorder the MINI-Plus has two screening questions. When a person answers the question negative, the person does not have the disorder and no further questions are asked in that particular disorder module. When the person answers positively to one or both of the screening questions, more detailed symptom questions are asked. In addition, time frames (current, past, or lifetime) of the disorder are questioned.

The validity and reliability of the MINI-Plus are not known yet, although it is believed that these would not differ much from its shorter version (Vliet et al., 2000).

**BSID-II.** The Bayley Scales of Infant Development (BSID-II) (Meulen, Ruiter, Spelberg, and Smrkovský, 2004) measures the mental, motor, and behavioral development of children from 1 to 42 months of age (Robertson, 2010). For this study, only the Mental Scale was administered, consisting of 178 items. The Mental Scale measures cognitive skills of the infant. It contains items concerning visual and auditory information processing, eye-hand coordination, imitation, language development, memory and problem solving ability (Brown & Anderson, 1999). The items were administered individually to the infant and the infant's response was recorded and scored respectively as (1), when the infant was able to complete the item or when reported by the mother, or as (0), when the infant was not able to complete the item.

The score of the infant was determined by the number of items for which positive scores were received. Raw scores on the Mental Scale were converted to a Mental Developmental Index (MDI), with a mean of 100 and a SD of 15, using age-specific norm

tables. Infants with a MDI lower than 70 were considered to have an extremely delayed development; MDI scores ranging from 70 and 84 were labeled as delayed development; MDI scores between 85 and 114 were labeled as normal development; and scores of 115 and higher were labeled as above average developed.

The chronological age of the infant determined which exact items were administered, thereby taking into account that some infants were delivered prematurely (i.e. < 37 weeks gestation), indicating a possible delay in the development. In case of pre-term infants, the starting point was reduced to mostly 5 months instead of 6 months. Suggested item orders were given in the manual, but flexibility in administration was allowed in ordering of items. To administer the items, explicit directions were provided in the manual, including position of the infant or showing the items to the infant.

Researchers had been trained in reliable administration and scoring of the assessments of each infant. The correlation of the inter-reliability in the study of Nellis and Gridley (1994) was .96 for the Mental scale and was assessed between the examiner and a rater that observed the administration. No inter-rater reliability was measured yet for this particular study.

**Still Face Procedure.** Mothers were videotaped interacting with their six-month-old infants during three two-minute episodes of the SFP. Infants were seated in a child seat between three barricades, both placed on a table. Infants were facing their mothers, who were seated on a chair at the table. Mother and infant were arranged in such a way that interactions between both could be videotaped; infants directly and mothers via the mirror situated above the head of the infant. Mothers were given instructions on how to act during these sessions. During the first phase, the play episode, mothers were instructed to interact with their infants as they would normally do, without the infants' pacifier and any toys. During the second phase, the still-face episode, mothers were requested to have a neutral expression on their face

and not respond to or touch their infant. In the final phase, the reunion episode, mothers were told to return to their interactive mode. When infants became highly distressed, mothers were allowed to, in case of phase 2, abort and move to the next phase, and, in case of phase 3, abort the procedure (Tronick et al., 1978; Mayes & Carter, 1990).

Interrater reliability was calculated based on 20 videotapes that were double coded using intraclass correlation coefficients, which ranged from .46 to 1.0, with a mean of .81. Infant behavioral responses to the SFP were continuously coded based on the manual of Miller and Sameroff (1998) in the categories of negative affect, gaze, and arching and/or squirming behavior. Infant behavior was more specifically coded using a one-minute coding system, because infant behavior tends to change much. Mother behavior in the SFP was continuously coded in the categories of sensitivity, intrusiveness, positive affect, and internalizing or helpless behavior during the two minutes of the play and reunion episode.

### **Data Analyses**

Data were analyzed using the Statistical Package for the Social Sciences (IBM SPSS; version 21.0).

At first, t-tests and chi-square analyses were performed to examine differences in mother and child behaviors during the SFP for depressed and non-depressed mothers.

Repeated measures ANOVAs were performed to examine the change in infant and maternal behavior during the SFP. To investigate the role of maternal depression on infant and mother behavior during the SFP, repeated measures ANOVAs were performed with maternal depression as between-subjects factor and episodes of the SFP as within-subjects factor. Finally, infant cognitive development was added to the repeated measures ANOVAs as covariate, to examine the effect of infant cognitive development on infant behavioral responses during the SFP, but only when infant cognitive development was associated with maternal depression and infant behavioral responses during the SFP.

### **Missing data**

For all analyses, mothers and their infants were excluded from analyses if they had missing data resulting in samples ranging from 48 to 52 participants. In analyses including the SFP, data of 51 mothers were included in these analyses, as one mother in this subsample did not complete the SFP paradigm. Some episodes during the SFP could not be coded, due to a blocked view at mothers' and/or infants' faces by the position of the mother.

In analyses including the BSID, data of four infants were missing, due to fussiness or tired behavior during the assessment.

## **Results**

### **Descriptives and preliminary analyses**

Table 1 presents means, standard deviations, minimum and maximum values for infant and mother variables. As well as *t* test and chi-square analyses to compare maternal and infant behavior for depressed and non-depressed mothers. Preliminary analyses showed that one variable needed to be recoded. Two groups of maternal internalizing or helpless behavior during the reunion were merged, due to a small amount of participants in one of the groups. Recoding resulted in improved skewness and kurtosis ( $|< 3|$ ).

Significant group differences with *t* test analyses showed that infant gaze during the still-face 2 episode ( $p < .01$ ), arching and/or squirming behavior during the play ( $p < .01$ ) and during the reunion 2 episode ( $p < .01$ ) differed for maternal depression (Table 1). Chi-square analyses showed that maternal internalizing or helpless behavior during the reunion episode differed for mothers having a depression or not ( $p < .05$ ).

### **Infant's emotion regulation during the SFP**

Whether the SFP-paradigm resulted in a classic SFP effect was investigated using repeated measures ANOVA with SFP-episodes as within-subjects variables and infant behavior as dependent variables. The reactions of the infants' responses (i.e. negative affect, arching

and/or squirming behavior, and gaze) were measured five times to each episode of the SFP: once during the play episode, twice during the still-face episode, and twice during the reunion episodes. Mauchly's test was found significant for all infant's emotion regulation variables, indicating that the assumption of sphericity had been violated. Therefore Greenhouse-Geisser corrections were reported when  $\epsilon < .75$ .

Table 1

*Infant and maternal descriptives*

Variables	All					Non-depressed (n = 23)		Depressed (n = 29)		t (df) $\chi^2$ (df)
	N	M	SD	Min	Max	M	SD	M	SD	
Mother variables										
Depression	52	0.56	.50	0	1	-	-	-	-	-
Sensitivity play	51	1.92	0.63	1	3	1.95	0.72	1.90	0.56	0.32 (49)
Sensitivity reunion	51	1.69	0.71	1	3	1.82	0.80	1.59	0.63	1.17 (49)
Intrusiveness play	51	2.16	0.76	0	3	2.05	0.90	2.24	0.64	-0.91 (49)
Intrusiveness reunion	51	2.20	0.72	0	3	2.09	0.81	2.28	0.65	-0.91 (49)
Maternal positive affect play	50	2.56	0.68	1	3	2.68	0.57	2.46	0.74	1.14 (48)
Maternal positive affect reunion	51	2.14	0.94	0	3	2.36	0.73	1.97	1.05	1.52 (49)
Internalizing or helpless play	51	0.08	0.27	0	1	0.09	0.29	0.07	0.26	<b>0.08 (51)</b>
Internalizing or helpless reunion	51	0.20	0.40	0	1	0.05	0.21	0.31	0.47	<b>5.57 (51)*</b>
Infant variables										
Mental Developmental Index	48	99.08	19.31	57	145	3.33	0.44	3.36	0.56	0.18 (46)
Negative affect play	51	0.78	0.90	0	3	0.82	0.96	0.76	0.87	0.23 (49)
Negative affect SF 1	51	1.06	1.01	0	3	0.82	0.85	1.24	1.09	-1.50 (49)
Negative affect SF 2	51	1.18	1.24	0	3	1.00	1.11	1.31	1.34	-0.903 (49)
Negative affect reunion 1	51	1.29	1.12	0	3	1.09	0.92	1.45	1.24	-1.18 (49)
Negative affect reunion 2	51	1.25	1.15	0	3	1.05	1.00	1.41	1.24	-1.17 (49)
Gaze play	51	1.71	0.81	0	3	1.82	0.73	1.62	0.86	0.86 (49)
Gaze SF 1	51	1.04	0.63	0	3	1.23	0.53	0.90	0.67	1.90 (49)
Gaze SF 2	51	0.94	0.76	0	3	1.27	0.77	0.69	0.66	2.91 (49)**
Gaze reunion 1	51	1.45	0.86	0	3	1.68	0.78	1.28	0.88	1.71 (49)
Gaze reunion 2	51	1.41	0.94	0	3	1.68	0.89	1.21	0.94	1.83 (49)
Arching and/or squirming play	51	0.65	0.89	0	3	0.32	0.65	0.90	0.94	-2.48 (49)*
Arching and/or squirming SF 1	51	0.86	1.02	0	3	0.82	0.73	0.90	1.21	-0.29 (47)
Arching and/or squirming SF 2	51	1.06	1.17	0	3	1.05	1.21	1.07	1.16	-0.07 (49)
Arching and/or squirming reunion 1	51	0.43	0.73	0	3	0.23	0.43	0.59	0.87	-1.94 (43)
Arching and/or squirming reunion 2	51	0.69	0.97	0	3	0.23	0.43	1.03	1.12	-3.56 (38)**

Note. Boldface indicates chi-square statistic; SF 1= first minute of the still-face episode; SF 2 = second minute of the still-face episode.

\* Significant at the .05 level (2-tailed). \*\*Significant at the .01 level (2-tailed).



Otherwise, Huynh-Feldt corrections were reported when  $\epsilon > .75$  (Field, 2009). When infant's emotion regulation was affected by the episodes of the SFP, Bonferroni post-hoc tests were used to find out where the differences occurred, i.e. during which specific episodes of the SFP.

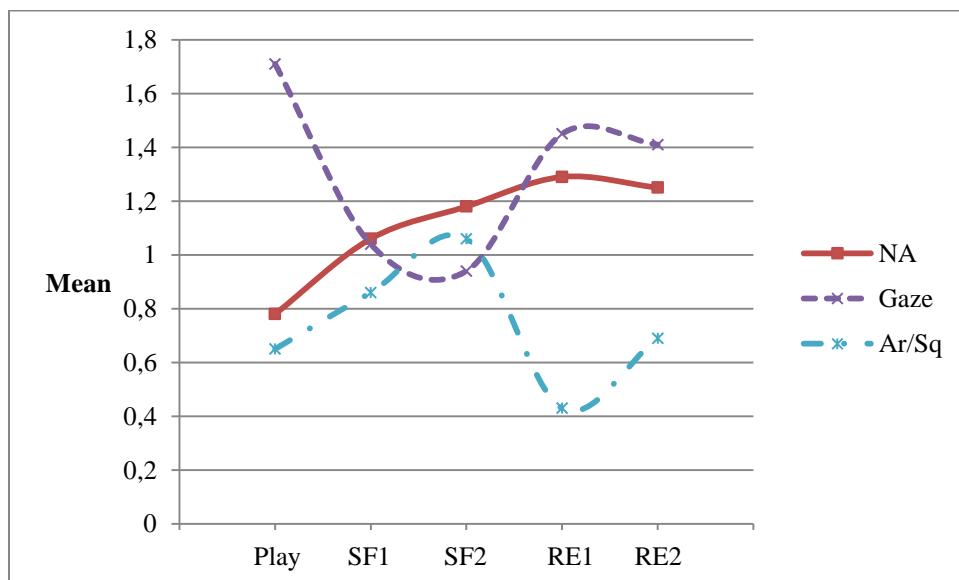
**Negative affect.** Results showed that negative affect of the infant, using ANOVA with Greenhouse-Geisser correction, was significantly affected by the episodes of the SFP-paradigm,  $F(2.96, 147.99) = .42, p < .01, \eta_p^2 = .08$ . Bonferroni post-hoc tests indicated that infants showed more negative affect, or cried and/or fussed more, during both reunion episodes during the SFP-paradigm compared to the play episode ( $p < .05$ ), but not during both still-face episodes compared to the play episode and to each other ( $p > .05$ ) (Figure 1).

**Gaze.** The ANOVA with Huynh-Feldt correction indicated that the mean scores of gaze toward mother for the episodes of the SFP were significantly different  $F(3.40, 169.94) = 13.92, p < .001, \eta_p^2 = .22$ . This result showed that gaze behavior of the infant was significantly affected by the episodes of the SFP. Bonferroni post-hoc tests displayed that infants gazed more during the play episode compared to the still-face episode ( $p < .001$ ) and that infants averted gaze during the still-face episode compared to the reunion 1 episode ( $p < .01$ ) and the reunion 2 episode ( $p < .05$ ), as indicated in Figure 1.

**Arching and/or squirming behavior.** The ANOVA with Huynh-Feldt correction indicated that arching and/or squirming behavior of the infant was significantly affected by the episodes of the SFP,  $F(3.46, 173.19) = 5.23, p < .01, \eta_p^2 = .10$ . Infants showed more arching and/or squirming behavior during the second minute of the still-face episode than the first minute of the reunion ( $p < .01$ ) (Figure 1). Infants did not show more arching and/or squirming behavior between both reunion episodes ( $p > .05$ ) and between the play and the first minute of the still-face episode ( $p > .05$ ).

### Maternal behavior during the SFP

Maternal behavior was observed during two episodes of the SFP: the play episode and the reunion episode. To analyze group means over these two episodes, repeated measures ANOVA was used with SFP-episodes as within-subjects factor and maternal behavior as dependent factor. As maternal behavior was only scored for two episodes the assumption of sphericity was met (Field, 2009). Sphericity, or equal variances across conditions, is only an issue when there are three conditions, due to differences between each pair of observed behavior. Therefore Mauchly's test could not be calculated.



*Figure 1.* Emotion regulations of the infants during the SFP. NA = negative affect; Ar/sq = Arching and/or squirming behavior, SF1= first minute of the still-face episode; SF2 = second minute of the still-face episode; RE1 = first minute of the reunion episode; RE2 = second minute of the reunion episode.

**Maternal sensitivity.** Repeated Measures ANOVA showed that the mean scores of maternal sensitivity were significantly different for the play and reunion episodes,  $F(1,50) = 1.41, p < .01, \eta_p^2 = .13$ , with higher mean scores during the play episode

( $M = 1.92$ ,  $SD = .63$ ) compared to the reunion episode ( $M = 1.69$ ,  $SD = .71$ ), as displayed in Figure 2. This result indicated that mothers showed more sensitive behavior toward their infants during the play episode than during the reunion episode.

**Maternal positive affect.** Measuring the differences in means for positive affect of the mother resulted in significant differences between the play and reunion episodes,  $F(1,49) = 10.471$ ,  $p < .01$ ,  $\eta_p^2 = .18$ . Higher mean scores were found for maternal behavior during the play ( $M = 2.56$ ,  $SD = .68$ ) compared to the reunion episode ( $M = 2.18$ ,  $SD = .90$ ), as indicated in Figure 2. This result showed that mothers smiled more often toward their infants during the play episode than during the reunion episode.

**Maternal intrusiveness.** The mean scores of maternal intrusiveness were not significantly different for the play and reunion episodes,  $F(1,50) = .20$ ,  $p > .05$ . This result indicated that the level of maternal intrusiveness was similar during the play and reunion episodes of the SFP.

**Maternal internalizing or helpless behavior.** Examining the mean scores of internalizing or helpless behavior resulted in non-significant differences between the play and reunion episode,  $F(1,50) = .35$ ,  $p = .83$ . This result indicated that mothers showed an equal amount of resignation during the play and the reunion episode.

### **Infants' emotion regulation and maternal depression**

Infants of non-depressed mothers gazed more toward their mothers compared to infants of depressed mothers ( $p < .001$ ) (Table 1). During the play episode and during reunion 2 infants of depressed mothers showed more arching and/or squirming behavior compared to non-depressed mothers ( $p < .001$ ) (Table 1). Group differences for depressed and non-depressed mothers were not significantly different for infant negative affect during the SFP.

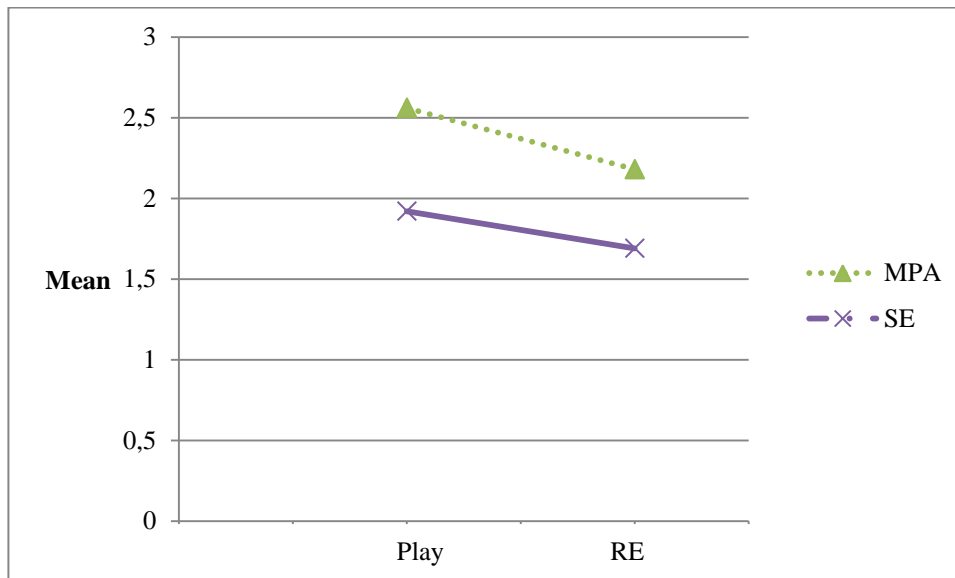


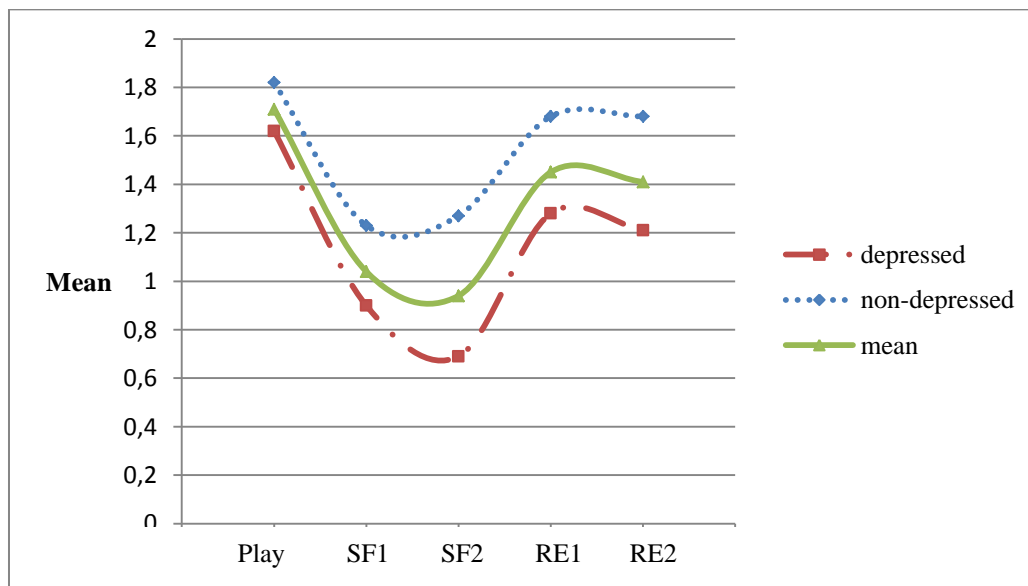
Figure 2. Maternal behavior during the SFP; MPA = maternal positive affect; SE = sensitivity; RE = reunion.

Repeated measures ANOVAs with SFP-episodes as within-subjects variable, maternal depression as between-subjects variable, and infant behavior, respectively gaze and arching and/or squirming behavior, as dependent variables were used to analyze infants' emotion regulation in reaction to the SFP-paradigm compared for depressed and non-depressed mothers.

**Gaze.** The ANOVA with Huynh-Feldt correction indicated that there was no significant interaction effect between maternal depression and episodes of the SFP on infant's gaze,  $F(3.46, 169.71) = .73, p = .56$ . Infants of depressed and non-depressed mothers showed a similar pattern of gaze toward mother in all episodes of the SFP. A significant main effect for maternal depression was present,  $F(1, 49) = 6.10, p < .05$ , indicating that infants of depressed mothers gazed less at their mothers than infants of non-depressed mothers (Figure 3).

**Arching and/or squirming behavior.** Infants of depressed mothers showed more arching and/or squirming behavior during the play ( $p < .05$ ) and the reunion two ( $p < .01$ ) episode compared to infants of non-depressed mothers (Table 1).

Arching and/or squirming behavior of the infant during the SFP was compared between depressed and non-depressed mothers. The ANOVA with Huynh-Feldt correction indicated that there was a significant interaction effect of maternal depression and episodes of the SFP on arching and/or squirming behavior,  $F(3.64, 178.43) = 2.61$ ,  $p < .05$ ,  $\eta_p^2 = .05$ . Infants of depressed mothers showed more arching and/or squirming behavior during the play and reunion episodes, as indicated in Figure 4. The main effect for depression was not significant, this indicated that the overall reactions of infants of depressed and non-depressed mothers were similar over the episodes of the SFP.

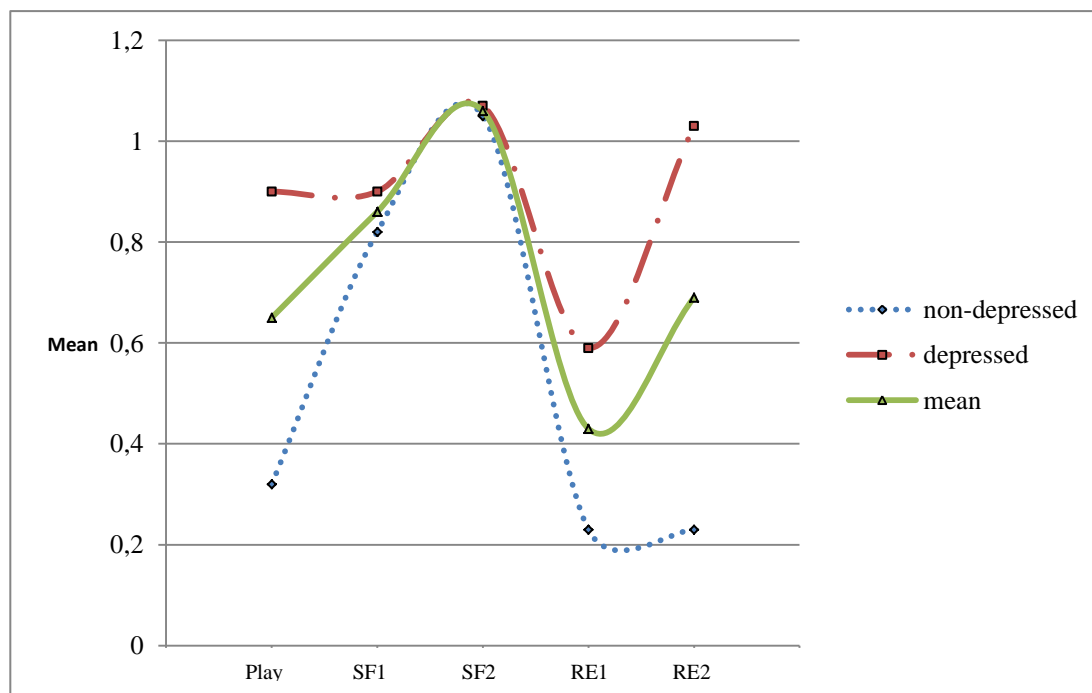


*Figure 3.* Effect of infant's gaze from maternal depression during the SFP. SF1 = first minute of the still-face; SF2 = second minute of the still-face; RE1 = first minute of the reunion; RE2 = second minute of the reunion.

Bonferroni post-hoc test indicated significant differences between group means between the still-face 1 episode and the reunion 1 episode ( $p = .05$ ) and between the still-face 2 episode and the reunion 1 episode ( $p < .05$ ), indicating that infants showed more arching and/or squirming behavior during the still-face episode than during the first minute of the reunion.

### Maternal behavior and maternal depression

Internalizing or helpless behavior differed for mothers with or without depression during the reunion of the SFP ( $\chi^2 = 5.57, p < .02$ ). Mothers who were feeling depressed showed more internalizing or helpless behavior during the reunion compared to non-depressed mothers (Table 1). No further group differences were found for depressed and non-depressed mothers on maternal behavior during the SFP.



*Figure 4.* Prediction of infant's arching and/or squirming behavior from maternal depression. SF1 = first minute of the still-face; SF2 = second minute of the still-face; RE1 = first minute of the reunion; RE2 = second minute of the reunion.

### **Child's cognitive development and maternal depression**

Infants' cognitive development of mothers who were feeling depressed ( $M = 3.36$ ,  $SD = .56$ ) was not significantly higher compared to the cognitive development of infants whose mothers were not feeling depressed ( $M = 3.33$ ,  $SD = .44$ ),  $t(46) = .18$ ,  $p = .86$  (Table 1).

No repeated measures ANOVAs with maternal depression as between-subjects variable, episodes of the SFP as within-subjects variable, and infant cognitive development as covariate were performed, since infant cognitive development was not associated with maternal depression.

### **Discussion**

This study investigated some factors that might possibly lead to the development of antisocial and other problem behavior. The effects of maternal mental health on maternal and infant behavior during the SFP, and the cognitive development of the infant were investigated. More precisely, the effect of the SFP on infant behavior was examined, as was the effect of the SFP on maternal behavior. The SFP procedure tends to be stressful for infants since mothers are not allowed to respond to their infants for two minutes, which tends to be incongruent with their infants' expectations. Results of this study suggested that infant negative affect, gaze, and arching and/or squirming behavior were affected by the episodes of the SFP. Also maternal sensitivity and maternal positive affect were affected by the episodes of the SFP. These results were in line with literature and indicated that the SFP elicited a classic still face effect for mother and infant behavior during the SFP. Therefore this hypothesis was confirmed. Investigating the influence of maternal depression on infant emotion regulation and maternal behavior during the SFP revealed that infants of depressed mothers averted gaze toward their mothers compared to infants of non-depressed mothers during all episodes of the SFP. Infants of depressed mothers showed more arching and/or

squirming behavior during the play and reunion episodes compared to non-depressed mothers. Arching and/or squirming behavior of the infant was not significantly affected by maternal depression only. Furthermore, maternal depression resulted in more internalizing or helpless behavior in mothers during the reunion episode. Thus, maternal depression can result in a different behavior pattern during the SFP for both mothers and infants. Therefore, these hypotheses are confirmed. Finally, no association between maternal depression and infant cognitive development was found in this study. This hypothesis is therefore rejected.

### **Infant behavior during the SFP**

Results of this study showed that infants gazed more toward their mothers during the play and reunion episode and averted gaze during the still-face episode. The results that infants averted gaze during the still-face compared to the play episode were confirmed by Braungart-Rieker, Garwood, Powers, and Notaro (1998), Field (1992), and Kogan and Carter (1990). Infants probably looked less to their mothers during the still-face episode because mothers did not respond to their infants actions to receive their mothers attention again. Another possible reason can be that infants avert gaze because they are frustrated with their mothers, due to incongruent expectations of the interaction between mother-infant dyad (Gunning et al., 2013). Otherwise, infants may focus more on themselves instead of their mothers to regulate their own emotions. They possibly avert gaze to down-regulate their distress (Ekas, Lickenbrock, and Braungart-Rieker, 2012).

The result that infants maintain an increased level of negative affect during the SFP was shown earlier by Mesman et al. (2009) and Field (1992). Infants with less optimal regulatory capacities show possibly a raised level of negative affect and gaze aversion during the SFP (Mesman, Linting, and Joosen, 2013).

In the reunion episode, infants showed an increase in gaze toward mother and an increase in negative affect. This last one, suggests the so-called 'carry-over' effect (Mesman



et al., 2009), meaning that infants maintain a higher level of negative affect after ending of the still-face episode. They do not return to baseline level. They probably have less regulatory capacities. Other studies, such as Kogan and Carter (1990), suggested also a carry-over effect for gaze behavior. However, in this study, gazing toward mother during the play and reunion episode did not significantly differ. A possible explanation for a higher level of averted gaze during the reunion episode compared to the play episode, is that infants show some recovery looking more toward their mothers, but they are probably unable to recover fully or return to baseline level as they still show higher levels of negative affect.

Another way for infants to cope with their distress during the SFP is arching and/or squirming behavior. Results of this study suggest that infants showed more arching and/or squirming behavior during the still-face 2, but not during the still-face 1 episode, compared with the reunion 1 episode. Probably, infants need some time to reach a certain level of distress when their mothers do not respond to their bids of attention or maybe their arching and/or squirming behavior increases when only showing negative affect does not have the desired result, i.e. mothers attention. Infants may use this method to provoke mothers' attention or to lose the energy that they have built up during the stressful episode (Ekas et al., 2012). When mothers interact again, their infants show less arching and/or squirming behavior during the reunion. Ekas et al. (2012) found that infants showed more negative affect in response to showing arching and/or squirming behavior, probably because mothers still did not focus their attention on their infants when they showed this kind of behavior. This can also be an explanation of the increase of negative affect during the still-face and reunion episode in this study.

### **Maternal behavior during the SFP**

Not only infant behavior, but also maternal behavior, was affected by the procedure of the SFP. In this study maternal sensitivity decreased significantly during the SFP. Even as,

maternal positive affect. These results can possibly be explained by the negative affect infants show during the still-face and reunion episode. As infants still show distress during the recovery, it may be more difficult for mothers to soothe their infants. McElwain and Booth-LaForce (2006) revealed results on being classified as secure as mothers showed more sensitive behavior toward their infants during distress. Mothers sensitive qualities are probably put to the test during the reunion episode since infants showed higher levels of distress compared to the play episode. Following infant's negative affect, sensitive mothers do not laugh when their infants are in distress, resulting in lower levels of positive maternal affect during the reunion episode. Furthermore, these results can also be explained from mother's point of view. For mothers the SFP is also an unnatural and forced procedure. When infants start to show negative affect during the still-face episode, it is reasonable that mothers find it difficult not to react on their infants. Consequently, mothers can feel more distressed than during normal interaction. Therefore, mothers' level of positive affect and sensitivity can decrease during the reunion episode compared to the play episode.

Mothers do not show more or less intrusive or internalizing or helpless behavior during the play and reunion episode. The investigations of these behaviors were more exploratory in this study and are not found in other studies since in other studies mother-infant dyads were investigated. However, it was expected that mothers would show more intrusive behavior during the reunion episode compared to the play episode, as well as more internalizing or helpless behavior. Since infants show more distress during the reunion episode, mothers may try harder to soothe their infants by touching them or distracting them with playing games and when infants remain distressed mothers may not know what to do to calm their infants, resulting in more resigned behavior. Reasons for these unexpected results can be that mothers are not used to this stressful procedure. It is possible that mothers already show higher levels of internalizing or helpless behavior or intrusiveness during the play.

Mothers are not allowed to play with their infants using their pacifier or toys, however, mothers may be more used to play with their infants with the help of these items.

### **Effect of maternal depression on maternal and infant behavior during the SFP**

Moreover the possible stressful procedure of the SFP, maternal depression may also negatively affect the behavioral responses of both mother and infant during the SFP. Results of this study suggest that infants of depressed mothers averted gaze more during all episodes of the SFP compared to infants of non-depressed mothers. This is consistent with study results of Cohn et al. (1990), where they stated that infants of depressed mothers show less engagement with the environment. This infant behavior can be a result of maternal behavior and explained by the mother-infant interaction. As depressed mothers are more withdrawn and self-occupied (Field, 1984; Cohn et al., 1990) during interaction with their infants, infants gaze less toward mothers and gaze more toward the environment or themselves.

Infants of non-depressed mothers avert gaze during the still-face but return almost to baseline level again during the reunion episode. This is consistent with findings of Ekas, Haltigan, and Messinger (2013). Though infants of depressed mothers avert gaze more during reunion compared to the non-depressed infants. Possibly non-depressed mother-infant dyads have more congruent interaction patterns compared to depressed mother-infant dyads (Mesman et al., 2009). Therefore, infants of non-depressed mothers are better able to regulate their emotions and more able to return to baseline when mothers are allowed to interact again (Gunning et al., 2013). Additionally, infants' expectations of their depressed mothers are more incongruent. Infants of depressed mothers can depend less on their mothers availability, therefore, they focus more upon themselves or upon the environment to regulate their own distress.

The combination of SFP episodes and maternal depression resulted in more arching and/or squirming behavior during the play and reunion episode. It is possible that infants of

depressed mothers feel more agitated in interaction with their mothers. During the play episode infants of depressed mothers are more distressed compared to infants of non-depressed mothers. Infants of non-depressed mothers show this stressful behavior when their mothers are not allowed to interact with their infants. During the still-face episode infants of depressed and non-depressed mothers both showed the same amount of arching and/or squirming behavior. It is unknown what the cause is of these differences in emotion regulation. Hypothetically, the interaction patterns in depressed and non-depressed mother-infant dyads differ. No differences in maternal sensitivity or intrusiveness was visible for depressed and non-depressed mothers in the current study, therefore results cannot be explained from maternal behavior. During the still-face episode infants of depressed and non-depressed mothers possibly show the same amount of arching and/or squirming behavior because this is stressful for all infants.

Otherwise, that infants of depressed mothers showed more arching and/or squirming behavior during the SFP can also be explained by the mother-infant interaction outside the SFP. As depressed mothers are more withdrawn (Field, 1984; Cohn et al., 1990) they interact probably less with their infants. Due to infants' expectations in interaction during its first six months (Mesman et al., 2009), the SFP is more stressful for infants of depressed mothers, because they are not used to this forced interaction.

Maternal depression did not have a significant effect on other infant behaviors during the SFP. Campbell, Cohn, and Meyers (1995) found differences between mothers with depression. They stated that some depressed mothers were able to pull themselves together and positively interact with the infants, others find it more problematic to put on a cheerful face. Earlier literature suggests that depressed mothers were less positive than non-depressed mothers in their interactions with their infants (Cohn et al., 1990). Depressed mothers show

less positive and more negative affective interaction with their infants during the first six months.

In contrast to the expectations, maternal depression did not have an effect on maternal sensitivity, intrusiveness, and positive affect. According to the literature, the quality of maternal style is less for mothers who are feeling depressed (Azak and Raeder, 2013). They show more harsh parenting (Turney, 2011) and show more withdrawn and intrusive behavior (Field, 1992). A possible explanation for these results in this study is the number of mothers (less than ten) that felt depressed during the second appointment. This could result in loss of power. Otherwise, the SFP could not be a proper procedure to measure maternal behavior, since this procedure could feel unnatural for mothers.

This study showed significant associations between maternal depression and maternal internalizing or helpless behavior. Depressed mothers showed more internalizing or helpless behavior during the reunion episode compared to non-depressed mothers. Possibly mothers who are feeling depressed are less able to soothe their infants, who feel distressed during the reunion. Attempts of the mother to calm down their infants may not work properly, resulting in increased levels of resignation of the mothers.

### **Effect of maternal depression on infant cognitive development**

Inconsistent with results of Hay et al. (2001), Deave et al. (2008), Azak (2012), and Field (1992) this study did not find significant effects of maternal depression with respect to infant cognition. This could be the result of the heterogeneous sample of HR- and LR-mothers in this study or because maternal depression was computed from various scores (i.e. prenatal or postnatal depression, depressed in the past, depressed at present, short and long duration of depression). Field (1992) mentions that infants show a ‘depressed’ style of interaction when their mothers are depressed. Additionally they showed a lower performance when they are one year old. However, when mothers were not depressed during the first months of their

infant's life, infants' development was no longer delayed at one year old. Hay et al. (2001) revealed long-lasting results on cognitive development, even when postnatal depression was brief. However, the cognitive development was measured when infants were four and eleven years old. Another reason that maternal depression was not associated with infant cognitive development could be that maternal depression in the current study was not based on official diagnoses. Therefore, the depression may not be serious enough to elicit significant results.

### **Limitations**

Several limitations of this study should be mentioned. First, in this study 52 mother-infant dyads could be included, and sample size may have been too small to demonstrate particular results. Already mentioned as a possible limitation was the means of classifying depression in the present study. The depression variable was composed of positive scores on either the MINI-Plus or the BDI-II, indicating that mothers felt depressed in the past or feel depressed during the first or second appointment. However, the duration of the depression was not taken into account in this study. Results on duration and timing of the depression seems also to be of influence. Forbes, Cohn, Allen, and Lewinsohn (2004) stated that infants of mothers with a history of depression were more likely to display negative affect and less likely to display positive affect during mother-infant interaction. However, Campbell et al. (1995) found only significant effects when the depression remained for six months or longer. Therefore, the timing and duration of depression can be further examined in a future study. Third, the sample is heterogeneous, consisting of HR- and LR-mothers, which might obscure linear associations. Finally, the episodes of the SFP may be too short for infants to regulate their behavior. Furthermore, the timing of the break may not be convenient for some infants. It can be argued that infants could feel distressed from the very first start when sitting in a child seat, resulting in higher levels of distress than is desired when the still-face episode starts.

### **Conclusion**

The current study investigated the effects of maternal depression on infant regulatory capacities and maternal behavior. This effect on behavioral responses was measured during the SFP, which is a situation that can be stressful for infants. Results of this study indicate that infants develop some regulatory capacities during the first six months of their lives. In response to a stressful situation infants showed more negative responses, and returned toward baseline levels when mothers were available to interact with them again. Additionally, mothers responded less positively after a stressful situation. In addition to the effects of the SFP, maternal depression also affects maternal behavior and the regulatory capacities of the infants. Mothers showed more resigned behavior after the stressful situation when they were feeling depressed and infants looked less toward their mothers during interaction and during stress exposure when their mothers feel depressed. They also showed more distressed behavior during interaction with their mothers. Associations between behavioral responses of the mother and infant emotion regulation need to be further investigated, even as the effect of the SFP on these factors.

Results of this study show the importance of determining maternal depression during pregnancy or early infancy as infants of depressed mothers show different coping strategies at six months old to down-regulate their negative affect. The knowledge of behavioral responses of both mother and infant can contribute to better understanding of infant's regulatory capacities during stress exposure. Furthermore, factors that contribute to the development of problem behavior can be distinguished.

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