Infant Behavior & Development 36 (2013) 587–598

Contents lists available at SciVerse ScienceDirect

Infant Behavior and Development

Robust patterns and individual variations: Stability and predictors of infant behavior in the still-face paradigm

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ARTICLE INFO

Article history:
Received 17 December 2012
Received in revised form 30 April 2013
Accepted 7 June 2013

Keywords:
Still-face paradigm
Infant behavior
Maternal sensitivity
Temperament
Longitudinal

ABSTRACT

In the present study we examined key issues regarding infant behavior in the still-face paradigm (SFP) in terms of individual variations, stability, and predictors. The sample consisted of 115 mothers and infants, with assessments at ages 3 and 6 months, including observations of maternal and infant behavior in the SFP, and parent reports of infant temperament. Both robust patterns and individual variations in infant SFP behaviors were found, with only a minority of infants showing the expected patterns for negative affect and gaze. Infant behavior patterns showed no stability from age 3 to 6 months, and infant gaze was related to more pronounced behavior changes across the SFP. Maternal sensitivity in the SFP baseline was related to some aspects of infant SFP behavior. Consistent with the differential susceptibility hypothesis, in infants with a more difficult temperament maternal sensitivity predicted a more pronounced expected pattern of changes in infant positive affect across the SFP, whereas this was not the case for infants with a more easy temperament.

The still-face paradigm (SFP) was first introduced by Tronick, Als, Adamson, Wise, and Brazelton (1978) to study infant behavior in reaction to sudden maternal unresponsiveness, and has since been used in many studies on infant development. A recent meta-analysis showed that the decrease in infant gaze and smiling and increase in negative affect during the still-face compared to baseline interaction are robust and found regardless of sample and procedure moderators (Mesman, Van IJzendoorn, & Bakermans-Kranenburg, 2009). In addition, the meta-analysis showed that infant behavior in the SFP is predicted by maternal sensitivity and that it predicts future attachment security. The few studies investigating temperament in relation to infant behavior in the SFP have shown inconsistent results (Braungart-Rieker, Garwood, Powers, & Notaro, 1998; Tarabulsy, Provost, Deslandes, St-Laurent, Moss, & Lemelin, 2003), and infant behavior in the SFP does not seem to be particularly stable across time (Cossette, Pomerleau, Malcuit, & Kaczorowski, 1996, Moore, Cohn, & Campbell, 2001; Toda & Fogel, 1993). To date, studies investigating the stability, predictors and outcomes of infant behavior in the SFP have only looked at the infant behaviors within episodes, rather than *changes* in infant behaviors across episodes, which actually represent the most crucial feature of the SFP. In the current study we examine infant behavioral changes in the SFP at age 3 and 6 months, looking at group-level patterns as well as individual variations in these patterns, and investigate their stability and predictors.

The still-face paradigm generally consists of a three-step face-to-face interaction with an adult: (1) a baseline normal interaction episode, (2) the 'still-face' episode in which the adult becomes unresponsive and maintains a neutral facial

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0163-6383/$ – see front matter
http://dx.doi.org/10.1016/j.infbeh.2013.06.004

expression, and (3) a reunion in which the adult resumes normal interaction. The SFP has inspired many researchers to study infant interactive behaviors and affect regulation in face-to-face interactions, addressing a wide variety of research questions. The effects of the SFP on infant behavior were tested in a series of meta-analyses (Mesman et al., 2009), showing a significant decrease in positive affect and gaze, and a significant increase in negative affect from baseline to still-face (the still-face effect), a significant increase in positive affect and gaze from still-face to reunion (the recovery effect) but no change in negative affect from still-face to reunion, and a significant decrease in positive affect and a significant increase in negative affect from baseline to reunion (the carry-over effect). These effects were found across different samples in terms of demographic and risk variables, and irrespective of procedural variations. The still-face effect occurs from age 1 month onwards (Bertin & Striano, 2006; Tronick et al., 1978) and is due to the break in normal social interaction rather than boredom (e.g., Gusella, Muir, & Tronick, 1988; Kisilevsky et al., 1998). There is also evidence for physiological responses to the SFP episodes that mirror the behavioral observations (e.g., Haley, Handmaker, & Lowe, 2006; Ham & Tronick, 2006; Weinberg & Tronick, 1996).

In terms of predictors of infant behavior in the SFP, the meta-analysis by Mesman et al. (2009) revealed that infants of mothers showing sensitive or positive behavior were more likely to show positive affect during the still-face episode. In two more recent studies, maternal contingent responding was related to more infant positive affect across all SFP episodes (Lowe et al., 2012), and with more social bids during the still-face episode (Mcquaid, Bibok, & Carpendale, 2010). Only a few studies have examined infant temperament in relation to infant behavior in the SFP, with mixed results. One study reported that parent ratings of infant negative temperament were related to lower levels of infant self-comforting behaviors during the still-face at age 4 months and observed negative temperament predicted lower levels of object orientation during the still-face (Braungart-Rieker et al., 1998). In contrast, Cohn, Campbell, and Ross (1991) did not find significant associations between maternal reports of infant irritability and infant SFP behavior at ages 2, 4, and 6 months. Another study found that maternal ratings of infant difficultness did not predict infant positive and negative affect or self-soothing during the still-face when correcting for other variables including maternal behavior (Tarabulsy et al., 2003). However, a significant interaction effect was found indicating that the strength of the association between maternal behavior and infant self-soothing in the SFP increased when infants were rated as less difficult. Thus, temperament may be investigated as a predictor as well as a moderator of parenting effects in relation to infant behaviors in the SFP.

Although individual differences in infant behavior in the SFP are apparently related to salient characteristics of infant and the caregiving environment, the stability of infant responses to the still-face is surprisingly low. Toda and Fogel (1993) found no significant correlations for negative affect, smiling, and gazing during the SFP between ages 3 and 6 months. In another study, no significant associations between emotional expressions (joy, negative, neutral, and interest) at ages 2.5 and 5 months were found for any of the SFP episodes (Cossette et al., 1996). In a study by Moore et al. (2001), negative affect was significantly stable between 4 and 6 months (but not between 2 and 4 months). Gaze aversion was stable between 2 and 4 months and between 4 and 6 months. Positive affect and crying showed no stability between any of the three ages. Overall, infant responses to the SFP do not seem to be particularly stable. The assessment of infant behavior in the SFP is based on only a few minutes of observation, which may be the reason for the low stability across time. However, as mentioned earlier, observations in these brief periods do reveal meaningful associations with other variables, suggesting that the brief observations do tap into more than just transient or random infant behaviors.

Maternal behavior may also be relevant to the stability of infant behaviors in the SFP. As discussed above, maternal sensitivity during the SFP has been found to influence infant responses, and if maternal behavior changes across time, so may infant behaviors. It may also be that infant state in terms of attention during the SFP influences the infant's affective responses, which may limit stability across time. Although the procedure should only be initiated when the infant is awake and alert and not in a state of negative affect, infants may still vary in the extent to which they are distracted and engage with the mother during each of the episodes. Thus, maternal behavior and infant attention may be important in trying to explain the lack of stability in infant behavior in the SFP.

Interestingly, previous studies regarding the stability and predictors of infant behavior in the SFP focused almost exclusively on behaviors within SFP episodes (e.g., negative affect in the still-face episode), rather than changes in behaviors between episodes (e.g., the increase in negative affect from baseline to still-face). The focus on within-episode behaviors ignores the unique properties of the SFP in terms of the changes in the social context across the episodes. To make full use of the design of the SFP, one would ideally investigate the changes in infant behavior rather than infant behavior in separate episodes. It may be that behavior changes across the episodes reflect a more trait-like response pattern and show stronger stability across time than mean-level infant behaviors within episodes. Changes in infant behavior across the SFP are also relevant to the link with maternal sensitivity. Infant behavior in the SFP reflects responses to social perturbation and is generally seen as a reflection of (violations of) infant expectations of maternal availability for social interaction. Thus, the magnitude and direction of changes in infant behaviors from baseline to the still-face episode may be particularly informative in relation to maternal sensitivity. Investigating changes in infant behavior across the SFP episodes would also shed light on the distribution of children showing different patterns of responses. To date, studies using the SFP have only reported on group-level changes in infant behavior, and although meta-analytic evidence shows that these changes are robust on a group level, this does not mean that all infants show the same patterns of behavior changes. However, to our knowledge individual differences in response patterns across the SFP have not yet been examined.

In this paper we investigate: (1) Group-level patterns of infant behavior across the SFP at ages 3 and 6 months; (2) Individual variations in patterns of infant behavior across the SFP at 3 and 6 months; (3) The stability of infant SFP behavior patterns from age 3 to 6 months; (4) Infant attention, infant temperament, and maternal sensitivity in relation to infant SFP behavior patterns at 3 and 6 months.

1. Method

1.1. Sample and procedure

Participants were recruited via midwifery practices in the western region of the Netherlands, and the Regional Coordination Programs of the Dutch National Institute for Public Health and Environment (NIPHE). To ensure enough variation in the main variables of interest (quality of parenting and child behavioral adjustment), we chose to oversample on parents with a low educational level, and on families with an older child scoring high on behavior problems. Inclusion criteria were (1) the first child scored either low or high on externalizing behavior on the Child Behavior Checklist (CBCL/1½ -5; Achenbach & Rescorla, 2000; cutoffs based on Van Zeijl et al., 2006), (2) the first child was younger than six years old, (3) the newborn second child who was the focus of the study was neither premature nor handicapped, (4) both children and parents lived together in one household and (5) both parents were Caucasian.

The recruitment resulted in a total of 115 families (57 with a high-externalizing first child, and 58 with a low-externalizing first child) who participated in both the 3- and 6-month home visits that included the still-face paradigm, observations of maternal sensitivity during bathing and play on mother's lap, and tests of infant cognitive development. Within this sample, maternal educational levels were distributed as follows: 30% low, 23% middle, and 47% high. The average maternal age at the time of birth of their second child was 32.6 years (*SD*: 4.6, range 19.3–40.0 years). The mean age difference between the target child and their older sibling was 32 months (*SD*: 11.81). Sixty percent of the target children were girls.

In all participating families both parents signed informed consent forms. To limit loss of participants through attrition, families were given gift coupons and small presents for the children after each home visit. Families also received two DVDs with a compilation of video footage from all home visits. Procedures and measures used in this study were approved by the Ethics Committee of the Institute of Education and Child Studies at Leiden University.

1.2. Instruments

1.2.1. The still-face paradigm

SFP (Tronick et al., 1978) was used to measure infant and maternal behavior at ages 3 and 6 months, and was conducted in the families' homes. The SFP consisted of three steps: (1) a baseline normal interaction (2 min), (2) the 'still-face' episode in which the adult becomes unresponsive while looking at the child with a neutral facial expression (1 min at age 3 months and 2 min at age 6 months), and (3) a reunion in which normal interaction is resumed (2 min). Mothers were allowed to touch the infant as they would do so normally during baseline interaction as well as reunion, but were not allowed to touch the child during the still face segment. The SFP was conducted when infants were awake and alert. If the infant cried during the majority of the procedure, the SFP was conducted again during an extra home visit (in 3 cases at 3 months, and 8 cases at 6 months, with no overlapping cases between assessments). A specially designed portable 'wall' was put around the infant seat to prevent distraction from the task. Infant and maternal behaviors were coded with an adapted version of the 4-point global rating scales (0–3) of the Mother Infant Coding System (Miller, McDonough, Rosenblum, & Sameroff, 2002). Infant behavior scales included positive affect (the frequency and intensity of infant smiles: 0 = no smiling; 3 = frequent moderate or several intense smiles), negative affect (the frequency and intensity of infant fussing and crying: 0 = no negative affect; 3 = few periods without fussing or crying), and gaze (the frequency of the infant looking at the mother's face: 0 = no gaze; 3 = consistent gaze during almost the entire segment). Each scale was coded for all three episodes separately. Maternal sensitivity (defined as following infant cues in an appropriate manner) was also coded on a 4-point scale separately for the baseline and the reunion (0 = virtually no sensitivity; 3 = consistently child-centered in responding to infant cues).

The SFP at ages 3 and 6 months as well as the infant and the maternal scales were independently coded by a team of 8 trained coders. Intercoder reliabilities (intraclass correlation, single rater, absolute agreement) were >.70 for all dyads on all scales. Episodes within one assessment and within target (infant or mother) were scored by the same person. All tapes were double coded for the maternal sensitivity scale since this scale was considered the more difficult one. When the two scores were not identical, a final score was given by two expert coders. The final baseline sensitivity scores for 3 and 6 months were then dichotomized using median splits to reflect less sensitive ($n = 30$ at 3 months and $n = 44$ at 6 months) versus more sensitive mothers ($n = 85$ at 3 months and $n = 71$ at 6 months). Infant gaze as a measure of infant attention was also dichotomized to reflect minimal gaze reflecting score 0: no gaze, or score 1: a few fleeting gazes never longer than a couple of seconds (3 months: baseline $n = 53$ and reunion $n = 67$; 6 months: baseline $n = 81$ and reunion $n = 107$) versus more than minimal gaze (3 months: baseline $n = 62$ and reunion $n = 48$; 6 months: baseline $n = 34$ and reunion $n = 8$).

1.2.2. Infant difficult temperament

Child temperament of the second child was measured with the Infant Characteristics Questionnaire (ICQ; Bates, Freeland, & Lounsbury, 1979) completed by the mother when the infant was 3 months olds. The ICQ was translated into Dutch and found reliable by Kohnstamm (1984). In the current study, a short form with 24 items was used (cf. Joosen, Mesman, Bakermans-Kranenburg, & Van IJzendoorn, 2012). A total score for difficult temperament was calculated based on standardized scores of all 24 items (Cronbach's alpha = .80). This total score was dichotomized at the median to reflect more easy infants (n = 57) versus more difficult infants (n = 58).

1.3. Analyses

1.3.1. Group level SFP effects

To examine group-level changes in infant behavior across the SFP in infant positive affect, negative affect, and gaze at both 3 and 6 months, we took a confirmative approach, testing the patterns found in the Mesman et al. meta-analysis with quadratic growth models, using the program EQS 6.1 for Windows (Bentler, 1995). We estimated measurement models for positive affect, negative affect, and gaze, separately for 3 and 6 months. Quadratic slopes were fitted on top of linear slopes. To limit the number of parameters in the model, we estimated error covariances only when necessary for obtaining acceptable model fit (i.e., X^2 insignificant at a .05 level or ratio X^2/df < 2, CFI above .95, and RMSEA below .08; see, Byrne, 2006). Based on the measurement models, we estimated models for each infant behavior, joining the 3- and 6-month assessments. We report the most parsimonious models, excluding non-significant elements. As the data on negative affect and gaze showed high multivariate kurtosis (normalized estimates were 15.12 and 11.40, respectively), we used robust estimates for models based on those data. We left out one multivariate outlier that scored particularly high on the first component in a PCA (z = 3.54). The corresponding child could clearly be distinguished from the rest of the sample, scoring consistently high (2 or 3) on negative affect, and low (0 or 1) on positive affect and gaze. Consequently, the sample in the growth models consisted of 114 children.

1.3.2. Variations in patterns of infant SFP behavior

To investigate variations in patterns of infant behavior across the SFP, we constructed dummy variables reflecting the absence or presence of each of the three possible patterns (decrease, no change, increase) from baseline to still-face and from still-face to reunion for positive affect, negative affect, and gaze at 3 and 6 months. In addition, for each infant behavior we examined the percentage of infants showing the expected pattern across the three episodes. In the growth models, we incorporated intercept and slope variations.

1.3.3. Stability of infant SFP behavior

We computed correlations between infant behavior in each of the episodes between the assessments at 3 and 6 months. In the growth models, intercepts and slopes at 3 months were correlated with intercepts and slopes at 6 months (provided that these parameters varied significantly).

1.3.4. Predictors of infant SFP behavior patterns

Infant temperament, infant attention, and maternal sensitivity in the SFP baseline episode were investigated as predictors of infant behavior patterns in the SFP by adding these (dichotomized) variables as between-subjects factors to the GLM Repeated Measures analyses at 3 and 6 months. Between-subjects effects reflect predictors of the mean levels of infant behaviors across the SFP, and between-subjects × within-subjects interaction effects reflect predictors of *changes* in infant behaviors across the SFP. In addition, infant temperament was examined as a moderator of the effects of maternal sensitivity by looking at three-way interactions, i.e., temperament × sensitivity × episode.

Finally, we tested whether infant gender was related to our main variables to see whether it should be included as a covariate, but this was not the case. A full table of correlations between all variables included in this study is available from the authors.

2. Results

2.1. Group-level SFP effects

We first checked whether the classic SFP effects as found in the meta-analysis by Mesman et al. (2009) were also present in our sample, using a confirmatory growth modeling approach. Fit measures for the three models (positive affect, negative affect, and gaze) combining the two assessments all indicate reasonable to good model fit (ratio X^2/df < 2, CFI .98–1.00; RMSEA .00–.05). The fixed part of the growth models (average regression coefficients) showed that for positive affect and gaze both the linear and the quadratic slopes were significant at both assessments, indicating significant quadratic growth. Quadratic growth in this case refers to patterns showing first a decrease and then an increase in values across time. This quadratic growth pattern is consistent with the classic SFP effects in which infants first show a decrease in positive affect and gaze (from baseline to still-face), followed by an increase in positive affect and gaze (from still-face to reunion). Indeed, the average growth curves were very similar to the patterns found in the Mesman et al. (2009) meta-analysis. For gaze, however, the pattern seemed somewhat less explicit than in the meta-analysis, showing only a slightly decreasing and increasing curve. For negative affect, the pattern from the meta-analysis was only found at the 6-month assessment. At age 3 months neither the linear nor the quadratic slope of negative affect were significant, indicating no significant development over the course of the SFP.

2.2. Variations in patterns of infant SFP behavior

In addition to looking at infant behavior patterns at a group level, we were specifically interested in examining individual differences in patterns of behaviors across the SFP. Table 1 shows that for positive affect, the majority of infants showed the expected decrease from baseline to still-face, and the expected increase from still-face to reunion, although a sizable minority showed no change from still-face to reunion. For negative affect and gaze however, only 4–17% of the infants showed the expected overall patterns, with the majority of infants showing no changes from baseline to still-face or from still-face to reunion. Additional analyses showed that about half of the infants showed no negative affect at all (score '0') in any of the episodes at each age, which

Table 1
Patterns of changes in infant behaviors across the SFP at 3 and 6 months.

	3 months (M3)		6 months (M6)		M3–M6 difference[a]
	%	(N)	%	(N)	
Positive affect					
Baseline to still-face					
Decrease (exp)	64.3	(74)	70.4	(81)	−1.02
No change	34.8	(40)	27.0	(31)	1.32
Increase	0.9	(1)	2.6	(3)	−1.00
Still-face to reunion					
Decrease	3.5	(4)	4.3	(5)	−0.33
No change	46.1	(53)	40.0	(46)	0.98
Increase (exp)	50.4	(58)	55.7	(64)	−0.87
Across 3 episodes					
Expected pattern	42.6	(49)	51.3	(59)	−1.42
Negative affect					
Baseline to still-face					
Decrease	5.2	(6)	5.2	(6)	0.00
No change	79.1	(91)	64.3	(74)	2.66*
Increase (exp)	15.7	(18)	30.4	(35)	−2.80*
Still-face to reunion					
Decrease	7.8	(9)	12.2	(14)	−1.09
No change (exp)	67.8	(78)	64.3	(74)	0.59
Increase	24.3	(28)	23.5	(27)	0.16
Across 3 episodes					
Expected pattern	4.3	(5)	11.3	(13)	−1.91
Gaze					
Baseline to still-face					
Decrease (exp)	32.2	(37)	26.1	(30)	0.98
No change	59.1	(68)	70.4	(81)	−1.74
Increase	8.7	(10)	3.5	(4)	1.62
Still-face to reunion					
Decrease	15.7	(18)	5.2	(6)	2.51*
No change	60.0	(69)	62.6	(72)	−0.42
Increase (exp)	24.3	(28)	32.2	(37)	−1.26
Across 3 episodes					
Expected pattern	16.5	(19)	14.8	(17)	0.34

Note: 'exp' refers to the expected change based on meta-analytic evidence.
[a] Differences in infant behavior changes between ages 3 months and 6 months were tested using paired sample *t*-tests. The column contains *t*-statistics.
* $p < .05$.

Table 2
Stability of infant and mother behavior from 3 to 6 months.

		r(115)
INFANT in SFP		
Positive affect	Baseline	.27**
	Still-face	−.07
	Reunion	.32**
Negative affect	Baseline	.17
	Still-face	.07
	Reunion	.14
Gaze	Baseline	.15
	Still-face	−.14
	Reunion	.03
MOTHER		
Sensitivity in SFP	Baseline	.40**
	Reunion	.28**

** $p < .01$.

means that the high percentage of infants in the expected 'no change' category from still-face to reunion in Table 1 does not reflect the expected pattern which refers to stable *high* levels of negative affect. For infant gaze, we did not observe a pattern of no gaze at all (score '0′) across the entire SFP, but a pattern of just minimal gaze (score 1) across all three episodes was found for 30% of infants at 3 months, and for 50% of infants at 6 months.

We also tested whether the patterns changed from ages 3 to 6 months by conducting paired sample *t*-tests (right-hand column in Table 1). The results indicate a few significant developmental changes, with more infants showing the expected increase in negative affect from baseline to still-face at 6 compared to 3 months, and fewer infants showing the unexpected decrease in gaze from still-face to reunion at 6 compared to 3 months.

Although the descriptive results in Table 1 suggest that there is some variation in patterns across individuals, in our growth models we found statistically significant variation in the growth curve only for negative affect at the 6-month assessment (variance = 0.23, $SE = 0.03$, $z = 7.00$, $p < .001$). The only other significant variations across individuals were found regarding baseline levels (i.e., the intercepts) of negative affect at both time points, positive affect at 6 months, and gaze at 3 months (*p*-values < .02). For positive affect at 3 months and gaze at 6 months, neither the slopes, nor the baseline levels significantly varied across individuals, suggesting that these patterns were very consistent across infants.

2.3. Stability from 3 to 6 months

Correlations were computed to examine the stability of infant and mother behavior in each of the episodes between the assessments at 3 and 6 months. Table 2 shows that of the nine infant variables (three behaviors in three episodes), significant 3-month stability was only found for positive affect during the baseline and during the reunion, whereas the two maternal sensitivity variables (baseline and reunion) were significantly stable from 3 to 6 months.

The stability of the baseline level of infant behaviors across the SFP can be examined in the growth models by correlating intercepts at 3 months with intercepts at 6 months. Stability in *changes* in infant behaviors across the SFP can be examined by correlating slopes between assessments. In addition, intercepts at 3 months may be correlated with slopes at 6 months. Considering that correlations can only be computed when there is significant variation in both correlated parameters, we could only correlate the intercept at 3 months with the intercept and slope at 6 months for negative affect. Both of these correlations were small and not significant ($r = .07$ with $p = .25$, and $r = .03$ with $p = .40$, respectively), meaning that the baseline level of negative affect at 3 months predicted neither the baseline level nor the growth rate of negative affect at 6 months.

2.4. Predictors of infant SFP behavior

2.4.1. Infant attention

Quite a few infants showed no more than minimal gaze in the various episodes of the SFP (30% at 3 months, 50% at 6 months) indicating lack of attention. We found that infants showing more than just minimal gaze in the baseline episode showed a significantly stronger decrease in positive affect from baseline to still-face than other infants at age 3 months, $F(1, 113) = 5.78$, $p < .05$, $\eta_p^2 = 0.05$ (Fig. 1A), and at age 6 months, $F(1, 113) = 19.85$, $p < .01$, $\eta_p^2 = 0.15$ (Fig. 1B). Infants showing more than minimal gaze in the baseline at 6 months also showed a larger increase in negative affect from baseline to still-face compared to other infants, $F(1, 113) = 5.86$, $p < .05$, $\eta_p^2 = 0.05$ (Fig. 1C). As could be expected, infant gaze also influenced the pattern of changes in gaze across the episodes at 3 months, $F(2, 112) = 12.87$, $p < .01$, $\eta_p^2 = 0.19$, and at 6 months, $F(2, 112) = 135.19$, $p < .01$, $\eta_p^2 = 0.71$. Infants showing more than minimal gaze during the baseline showed the expected pattern of decrease followed by increase in gaze, whereas gaze showed very little change across the episodes in infants who showed little gaze in the baseline.

We also tested the effects of infant gaze in the reunion on infant affect changes between the still-face and the reunion episodes. Infants showing more than minimal gaze in the reunion episode showed a larger increase in positive affect from still-face to reunion than other infants, at both 3 months, $F(1, 113) = 6.86$, $p < .05$, $\eta_p^2 = 0.06$ (Fig. 2A), and 6 months, $F(1, 113) = 14.93$, $p < .01$, $\eta_p^2 = 0.12$ (Fig. 2B).

2.4.2. Infant temperament

There were no significant effects of infant temperament on infant SFP behavior at 3 months. At 6 months, infants with more easy temperaments showed more positive affect during the SFP, $F(1, 113) = 4.82$, $p < .01$, $\eta_p^2 = 0.04$, which was reflected in more positive affect at baseline ($p < .05$), and a similar trend in the reunion ($p = .059$). Also at 6 months, infants with more easy temperaments showed more gaze during the SFP, $F(1, 113) = 4.04$, $p < .05$, $\eta_p^2 = 0.04$, with post hoc *t*-tests revealing more infant gaze in the still-face episode only ($p < .01$). Infant temperament was not related to infant behavior *changes* across the SFP at either age.

2.4.3. Maternal sensitivity in the SFP baseline

For maternal sensitivity in the SFP baseline, we found that infants with more sensitive mothers showed more gaze during the SFP at 3 months, $F(1, 113) = 10.91$, $p < .01$, $\eta_p^2 = 0.09$, and that this was the case for all three episodes. At 6 months no between-subjects effects were found. Looking at the effect of maternal sensitivity in the SFP baseline on *changes* in infant behaviors across the SFP, we found a significant effect for infant gaze at 6 months, $F(2, 112) = 4.57$, $p < .05$, $\eta_p^2 = 0.08$. Infants of insensitive mothers showed a stronger increase in gaze from still-face to reunion ($p < .01$), and a stronger increase in gaze from baseline to reunion ($p < .01$) than infants of sensitive mothers. In fact, whereas infants of sensitive mothers showed lower gaze during the reunion compared to baseline (a sign of a carry-over effect), infants of insensitive mothers actually showed higher gaze during the reunion compared to baseline.

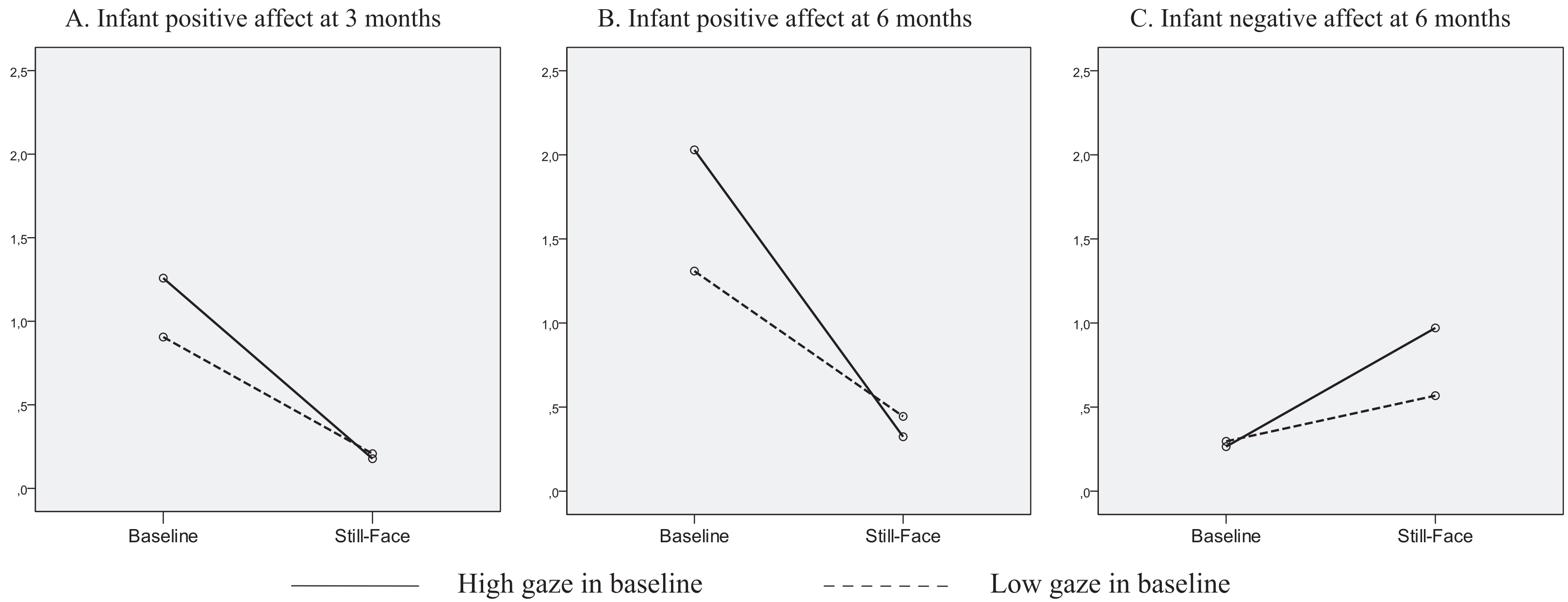

Fig. 1. The effect of infant gaze in the baseline episode on infant changes in affect from baseline to still-face.

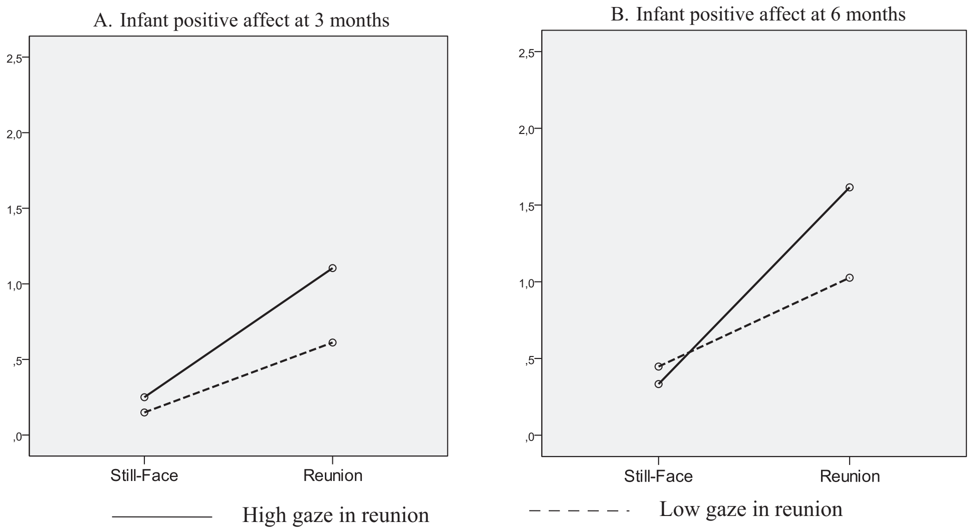

Fig. 2. The effect of infant gaze in the reunion episode on infant changes in affect from still-face to reunion.

In addition, infant temperament was tested as a moderator of the effect of maternal sensitivity in the SFP on infant behavior in the SFP. Infant temperament was not related to maternal sensitivity at ages 3 and 6 months. The results of the moderation test showed a significant moderation for infant positive affect at age 3 months, $F(2,110) = 4.37$, $p < .05$, $\eta_p^2 = 0.07$. Within-subjects contrasts and inspection of the plots revealed that in more difficult infants, maternal sensitivity in the SFP baseline predicted a more pronounced expected pattern of infant positive affect across episodes (see Fig. 3). In more easy infants maternal sensitivity was not related to infant positive affect changes across episodes.

2.4.4. Maternal sensitivity, infant attention, and the SFP effect

The results presented above show that at 3 months higher maternal sensitivity in the SFP baseline was related to higher infant gaze in the baseline and reunion, which in turn was related to a more pronounced expected positive affect pattern across the SFP episodes. To test whether baseline infant gaze mediated the association between baseline maternal sensitivity and infant positive affect changes from baseline to still-face, we conducted a GLM Repeated Measures analysis for positive affect across episodes, with both baseline infant gaze and baseline maternal sensitivity as between-subjects variables. The results showed that only infant baseline gaze remained a significant predictor of a stronger decrease in positive affect from baseline to reunion, $F(1, 112) = 4.50$, $p < .05$, $\eta_p^2 = 0.04$. The analyses were repeated for infant gaze in the reunion in relation to infant positive affect changes from still-face to reunion, and showed that only infant gaze in the reunion was related to a stronger increase in positive affect from still-face to reunion, $F(1, 112) = 6.83$, $p < .05$, $\eta_p^2 = 0.06$. These results suggest that the association of maternal sensitivity in the SFP baseline and infant positive affect patterns across the SFP is mediated by infant gaze. At 6 months there was no pattern of relations that warranted a test of a mediation model.

2.4.5. Summary of predictors

Table 3 provides a summary of the results regarding the predictors of infant SFP behavior, and shows that overall, infant attention in the SFP as indicated by higher levels of gaze was the most consistent predictor of several infant SFP behavioral patterns at both ages. Maternal sensitivity in the SFP baseline predicted only infant gaze, and predicted the expected SFP pattern for positive affect specifically in more difficult infants. In addition, most effects were found on infant positive affect and gaze, rather than on infant negative affect.

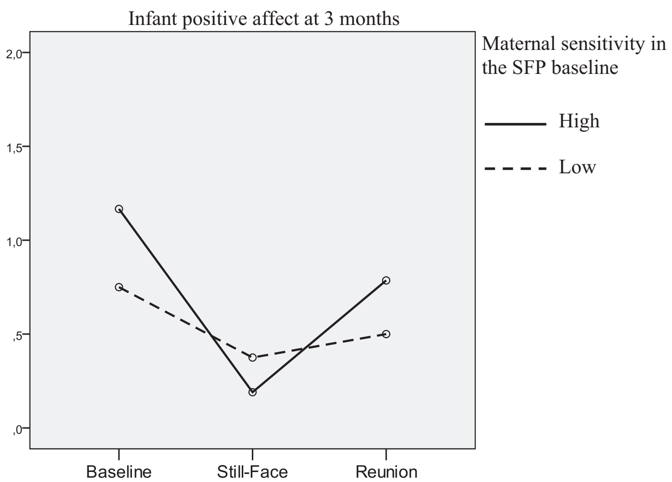

Fig. 3. The effect of maternal sensitivity in the SFP baseline on infant positive affect patterns at age 3 months in infants with a more difficult temperament.

Table 3
Summary of results regarding variables related to infant behavior in the SFP.

	Age	Positive affect	Negative affect	Gaze
Infant gaze in SFP (B and R)	3	Larger decrease B to SF	–	Stronger expected pattern
	6	Larger decrease B to SF	Larger increase B to SF	Stronger expected pattern
Infant difficult temperament	3	–	–	–
	6	Lower in B and R	–	Lower in SF
Maternal sensitivity in SFP	3	–	–	Higher in B, SF, and R
	6	–	–	Lower increase SF to R
In more difficult infants only				
Maternal sensitivity in SFP	3	Stronger expected pattern	–	–
	6	–	–	–

Note: Descriptions in the cells refer to the effects of higher levels of the predictor on the infant behaviors, e.g., more infant gaze at age 3 and 6 months was related to larger decreases in positive affect from baseline to still-face.
B = Baseline, SF = Still-Face, R = Reunion.

3. Discussion

The present study showed that even when the classic pattern of changes in infant behaviors across the still-face paradigm are found on a group level, the patterns of behavior do vary across individuals. The expected patterns for positive affect were found in about half of the infants, but only a small minority of infants showed the classic patterns of changes in negative affect and gaze that were found on the group level. Infant behavior within SFP episodes and changes in infant behavior across episodes showed very little stability from age 3 to 6 months. Infant gaze in the baseline and reunion were related to more pronounced behavior changes across the SFP. There were also some associations between infant behavior in the SFP and infant temperament and maternal sensitivity in the SFP baseline, with maternal sensitivity predicting the expected SFP positive affect pattern specifically in more difficult infants.

Our group-level analyses confirm meta-analytic findings regarding the changes in infant gaze and affect across the SFP. We added to previous studies and the meta-analytic evidence by adopting a confirmatory growth modeling approach, which has not been done before. With this approach the pattern for negative affect at age 3 months was not found (although it was found in the GLM analyses), indicating that this pattern is not particularly strong. The growth modeling analyses also showed that there was virtually no significant variation around the expected patterns. However, this finding is based on confirmatory analyses of a priori defined patterns, which does not preclude the existence of individual variations per se. The majority of infants indeed showed the pattern of a decrease in positive affect from baseline to still-face, and about half of the infants showed the total expected pattern including an increase in positive affect from still-face to reunion. However, we were surprised to find that less than 20% of infants showed the expected changes in negative affect and gaze across the SFP episodes. In fact, many infants actually showed no changes in negative affect and gaze across the episodes, with most infants showing no negative affect at all, and only minimal gaze. To our knowledge, there have been no previous reports of similar analyses looking at individual variations on the expected patterns of infant behavior changes across the SFP. In addition, we found very little stability from age 3 to 6 months of infant behavior within episodes. This is consistent with findings from other studies (Cossette et al., 1996; Toda & Fogel, 1993), and we extended these results by showing that *changes* in infant behavior were also not stable from 3 to 6 months. The individual variations in infant behavior patterns and their lack of stability across time raise important issues about the meaning and origins of infant behavior in response to the SFP. These results could reflect the fact that infant development is characterized by behavioral reorganization (Sroufe, 1996). Given that infant SFP behavior at various ages has been found to predict child outcomes such as attachment security (Mesman et al., 2009), variations between infants in their responses to the SFP do appear to be meaningful even though they are not stable.

Attempting to further explain the findings regarding pattern variations and lack of stability, we examined infant SFP behavior in relation to infant gaze in the SFP baseline and reunion (as indicators of infant attention to the situation), infant temperament and maternal sensitivity. Our results showed that infant gaze was an important predictor of infant response to the SFP, in that infants who showed more than just minimal gaze in the baseline were more likely to also show the expected behavior changes across episodes. Apparently, even though the SFP was conducted when the infants were awake and alert, there are variations in the extent to which the infants actually attended to the mother. Infants showing a lack of attention to the mother are likely to have missed the changes in maternal responsiveness across episodes, and were therefore less likely to show the expected behavior changes. Interestingly, at age 3 months infant gaze in the baseline in turn was predicted by maternal sensitivity during the baseline. We found a significant mediation model showing that when mothers were more sensitive in the SFP baseline, infants showed higher levels of gaze, and were therefore more attentive to the interaction, leading to more pronounced SFP effects on infant positive affect.

The finding that maternal sensitivity relates to more infant gaze is consistent with the literature on the mutually regulated nature of adult-infant interactions (e.g., Brazelton, Koslowski, Main, Lewis, & Rosenblum, 1974; Field, 1994; Trevarthen, 1977). Infants rely on the adult to regulate their emotions, and for this dyadic regulation to succeed, both parties need to monitor the other's expressions and respond accordingly. Key characteristics of sensitive parenting are receiving infant signals and responding appropriately to these signals (Ainsworth, Bell, & Stayton, 1974). Thus, the sensitive parent is doing her part to facilitate mutuality, which positively affects the infant's openness to coherent interaction, as shown by gaze toward mother. The finding that infant gaze and attention is an important predictor of infant responses to the SFP seems to be related to previous findings about the timing of the still-face episode. If the still-face episode begins when an infant has just started to orient toward its mother, the effects on infant behavior are much stronger than if the still-face begins when the infant has just reached a peak in interacting with the mother (Fogel, Diamond, Langhorst, & Demos, 1982; Stoller & Field, 1982). These findings can be linked to our own findings regarding infant gaze and attention. Orientation toward mother.suggests attention, which indeed predicts a stronger response to the still-face, as we also found. Having reached a peak in interaction with mother as evidenced by a smile suggests that attention is about to drop (Brazelton et al., 1974), which indeed predicts a less strong effect of the still-face on infant behavior. Thus, timing of the still-face episode as well as timing of the entire SFP in terms of infant attention is an important issue when using this paradigm.

The finding regarding moderation by infant temperament are intriguing and add a new dimension to the role of maternal sensitivity in explaining infant responses to the SFP. In more difficult infants we found associations between maternal sensitivity and infant SFP responses that were not found for more easy infants, or for the group as a whole. The pattern of this result is reminiscent of the notion of differential susceptibility, i.e., individual differences in vulnerability to environmental influences for better and for worse (Belsky, 1997; Belsky, Bakermans-Kranenburg, & Van IJzendoorn, 2007). According to this framework, individuals with certain temperamental or genetic characteristics respond more strongly to the environment, both in a positive way by benefiting more from positive influences (e.g., sensitive parenting), and in a negative way by suffering more from negative influences (e.g., parental unavailability). Our results are in line with this pattern. More difficult infants with highly sensitive mothers showed a stronger decrease in positive affect compared to more difficult infants with less sensitive mothers. This was not found for more easy infants, suggesting that the more difficult infants suffered more from a withdrawal of sensitive parenting than the more easy infants. In addition, more difficult infants of sensitive mothers showed a stronger increase in positive affect from still-face to reunion than difficult infants of less sensitive mothers. This was not found in the more easy infants, suggesting that the more difficult infants benefited more from the reestablishment of sensitive parenting than their more easy counterparts. The SFP appears to be particularly suited to testing the differential susceptibility hypothesis, because the environment changes rapidly from parental availability to withdrawal and back, allowing for the investigation of individual differences in susceptibility to changing and highly standardized environmental circumstances.

In this study we examined factors in relation to infant behaviors within episodes as well as to infant behavior changes across episodes. This approach has shown some merit, as differences in infant behavior patterns were identified in relation to other variables such as maternal sensitivity and infant temperament. This approach also showed that patterns of infant behavior changes did not improve the longitudinal stability of infant responses to the SFP. Thus we have shown that neither infant behavior within SFP episodes nor patterns of infant behavior changes between episodes show significant stability across a 3-months period.

This lack of stability remains an intriguing issue, given that variations in infant responses to the SFP are meaningfully related to other variables, suggesting that they do tap into some characteristics that have a more structural basis. On the other hand, one may argue that the fact that infant attention and maternal behavior in the SFP baseline appear to play a significant role in predicting infant responses means that situational factors are also important. Infant attention in the form of infant gaze in the baseline was not significantly stable across time, suggesting that this factor may explain some of the lack of stability of infant responses. However, maternal sensitivity was significantly stable across assessments and related to infant behavior in the SFP, suggesting that there are some structural factors that could have promoted stability in infant responses, but did not. It may be that the stability of maternal sensitivity simply is not strong enough to ‘fix’ the infants’ responses to the SFP and that situational factors and aspects of infant state are equally important. It would therefore be helpful to include quite detailed assessments of the infant’s state at the start of the procedure. It may be that subtle variations in infant mood or distractedness have a substantial impact on their responses to the SFP, thus limiting the longitudinal stability of these responses.

Contrary to most studies in this field, we used a macro-level coding system with global codes rather than a micro-level coding system based on frame-to-frame observations. In addition, we conducted the SFP in the families’ homes rather than in the lab. It is interesting to note that the group-level patterns of infant behaviors across the SFP that we found using these procedures were identical to those found in the meta-analysis, which included almost only studies using micro-level observations and lab-based procedures. Thus, it seems that to identify the classic SFP effects, the observation procedures and study location are of little consequence, which confirms the assertion that these effects are found irrespective of procedural variations (Mesman et al., 2009).

It could be argued however, that the use of a macro-level coding system has influenced our finding that many infants do not actually shows the classic behavioral patterns across the SFP. It may be that changes in these infant behaviors across episodes are very subtle and that the 4-point scales used in the present study were not sensitive enough to detect these. For instance, it is possible that infant gaze affect was scored as ‘1′ (i.e., minimal gaze as evidenced by a few fleeting looks at mother) during both the baseline and the still-face, whereas on a micro-level the infant did show a slight decrease in gaze between those episodes, but still fitting in the ‘1′ category within the global coding system. Thus it is possible that such subtle changes can only be detected properly when employing a micro-level observational approach. However, the majority of the sample had scores of ‘0′ on negative affect during each of the episodes, indicating that no negative affect was observed at all which means that these scores would also have been ‘0′ when using a micro-level system. This suggests that the finding that many infants do not show any changes in negative affect across the SFP would also have been found when using a micro-level approach. Nevertheless, replication studies using micro-level observation measures are needed to elucidate these issues.

We also asked ourselves whether the fact that the SFP was conducted at home could have influenced the infants' responses to the procedure. A lab room is likely to contain fewer distracting stimuli as these rooms tend to be rather bare with only the equipment that is needed to conduct the experiment, whereas family homes contain multiple potential distracters (e.g., pets, pictures, toys, etc.). However, in this study we used a specially designed portable 'wall' that we put around the infant seat to prevent distraction. This way, the infant saw only white surfaces on either side of the seat, and mother in the front, minimizing the potential for distraction by environmental stimuli. Although visual distracters were mostly eliminated, we cannot rule out that sounds from the environment or other factors had an influence on the infants' distractibility.

In conclusion, the current study showed that even though the classic pattern of infant behavioral changes across the still-face paradigm are robustly found on a group level, only a minority of infants actually show these patterns, and that these patterns are not stable over a period of 3 months. Given the apparent importance of infant attention and maternal sensitivity in predicting infant responses to the SFP, more detailed and extended assessments of these variables are warranted to fully understand individual variations in infant SFP behavior. In addition, the SFP appears to be a particularly interesting tool to test the differential susceptibility hypothesis, as rapid changes in maternal availability provide a good measure of environmental changes that may impact groups of infants in different ways depending on their temperamental characteristics.

Acknowledgements

This study was conducted with grants from the Rommert Casimir Institute (Research Institute of Education and Child Studies at Leiden University, the Netherlands), and by The Netherlands Organization for Scientific Research NWO in the form of a VENI grant awarded to Judi Mesman. Support from the European Research Council (Starting Grant to Judi Mesman), and NWO (VIDI and VICI to Marian Bakermans-Kranenburg, and SPINOZA Prize to Marinus van IJzendoorn), is gratefully acknowledged.

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