



Infant responses to maternal still-face at 4 and 9 months

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ABSTRACT

This study investigated developmental changes in infant responses to maternal still-face (SF) situations. Infants (21 males and 25 females) of Japanese mothers were observed in a face-to-face SF paradigm, comprising four phases (normal/SF/normal/SF), at two infant ages (4 and 9 months). The infants' facial expression, gaze direction, and vocalization were coded in both SF and normal interaction conditions. The results indicated that infants at both ages showed a decrease in displaying positive facial expression and gazing at their mothers during SF conditions. The 4-month-old displayed emotional expression and directed their gaze toward their mothers more frequently than the 9-month-old. However, the 9-month-old vocalized more often in SF situations, attempting to elicit responses from their mothers. The "carry-over" effect was observed only in 9-month-old. The results were discussed in the context of developmental changes in infants' social skills to cope with an emotionally stressful situation.

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1. Introduction

The still-face (SF) situation, where parents stop interacting with their infants and keep their faces neutral without talking to their infants while maintaining eye contact, has been used to investigate infants' responses to sudden changes in the emotional expressions of their parents (as a review, [Adamson & Frick, 2003](#)). The SF situation is one of the most robust procedures for testing infants' understanding of natural interaction patterns.

When mothers become still-faced, infants respond with behaviors involving decreased positive affect (i.e., smiling or laughing) and increased negative affect (i.e., fussing or crying), or by averting their gaze. On the other hand, they try to elicit their mother's attention by positive affect and vocalization ([Moore, Cohn, & Campbell, 2001](#); [Tronick, Als, Adamson, Wise, & Brazelton, 1978](#); [Weinberg & Tronck, 1994](#)). These behaviors reflect the self-regulation of emotion as well as infants' social expectations and sensitivities to the emotional expressions of others. Thus, the way in which infants respond to others' SFs may change, depending on their social-cognitive and emotional development. However, a large amount of research on the subject comprises cross-sectional studies; few longitudinal studies that trace developmental changes in infants' responsiveness to the SF procedure have been conducted. One of the purposes of this study is to examine age-related changes in strategies to cope with the emotionally stressful experience of a SF situation. We observed infant responses to the SF at 4 and 9 months, because it is during these periods that infants rapidly develop the social skills for emotional expression and responsiveness in face-to-face interactions, followed by the acquisition of the skills for triadic interactions ([Tomasello, 1995](#)).

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A majority of the studies on the SF response retain the structure employed by Tronick et al. (1978): three, 90- to 180-s periods of mother–infant interaction. First, the mothers interact with their infants normally; next, they expose the infants to the SF situation; and finally, they put them back in a regular social interaction. In addition to the original procedure, we created another SF situation after the second normal interaction in order to compare infant responses, not only between the SF and normal interactions but also between the two SF situations. Although other methodological elements (e.g., the age of the infants, the length of the session, coding procedures) varied considerably across studies, most research on this paradigm has focused only on the still-face episode after the normal interaction. We expected that focusing on the differences between two SF periods, as well as between SF and normal interaction periods, would provide us with an idea of the extent to which infants at each age are sensitive to the emotional expression of others as well as the extent to which they can regulate their emotional states and tolerate a frustrating situation. Although some researchers (e.g., Rochat, Striano, & Blatt, 2002; Striano, 2004) had repeated the SF episodes in the different conditions, no study on the SF effect has been conducted exposing the infants to the two SF episodes in the same procedure.

In addition, in a large number of previous studies, the results on sex differences with regard to the SF effect are inconsistent. Toda and Fogel (1993) scarcely found any sex differences, while Mayes and Carter (1990) and Stoller and Field (1982) found that girls displayed more distress than boys. On the other hand, Braungart-Rieker, Courtney, and Garwood (1999) and Cohn and Tronick (1983) indicated that girls were more positive than boys. We also compared male and female infants' responses to the SF procedure from the point of view of sex differences in emotional expression and self-regulation (Weinberg, Tronick, Cohn, & Olson, 1999).

With the exception of some reports on Chinese (Kisilevsky et al., 1998) and African-American infants (Segal et al., 1995), most studies on the SF situation have examined responses in samples of Caucasians. Compared with North Americans, Japanese and Chinese adults discourage the expression of strong emotion in babies (Fogel, 1993; Kuchner, 1989). Consequently, by the end of the first year, Chinese and Japanese infants smile and cry less than American infants do (Camras et al., 1998). Our study deserves attention as research on the maternal SF responses of non-Caucasian, Japanese infants.

2. Methods

2.1. Participants

Infants and mothers were recruited from hospitals in two areas of Japan (Mie and Osaka prefectures), and videotaped in laboratory playrooms when the infants were 4 and 9 months old. Out of the 70 participants (34 males and 36 females), 8 failed to complete the entire session because they cried continuously (at 4 months, $n = 2$) or fussed (at 4 months, $n = 2$ and at 9 months, $n = 4$). The data of 16 participants could not be used because of experimental errors at either 4 or 9 months. The remaining 46 mother–infant dyads (21 males and 25 females) were included in the final sample. All the mothers were from middle or higher household income families, and had at least graduated high school. All the babies were full-term infants who had no medical complications. Twenty-two infants had more than one sibling.

This research was conducted in accordance with the Japan Science and Technology agency (JST) ethical committee in the treatment of participants.

2.2. Procedures

Observations were conducted in a laboratory playroom (2.75 m $\times$ 2.75 m) with a one-way mirror. The playrooms in the two prefectures were identical and each was equipped with seven VTR cameras, a microphone, and an infant seat in the center of the room. Mothers were seated on the floor in front of their infants, who were in the infant seat. Mother and infant were videotaped via synchronized cameras. The experiment was conducted while the infants were alert (i.e., eyes open and attention directed toward external stimuli).

In the normal interaction condition, each mother was asked to interact with her infant in a normative manner, just as she did at home. In the SF condition, the mothers were asked to freeze their face while gazing at their infants and stop talking without any movement. The procedure was as follows: (1) interaction in the normal interaction condition (NI1) for 30 s; (2) in the SF condition (SF1) for 1 min; (3) another normal interaction condition (NI2) for 30 s; (4) another SF condition (SF2) for 30 s. The order of these conditions was the same for all the participants.

An experimenter behind the infant seat signaled to the mothers when to shift conditions by waving his/her hand.

2.3. Measures

Infant behaviors were coded in three separate dimensions through the videotapes: (1) facial expression, which was coded on two dimensions (positive/negative); (2) gaze at mother; (3) vocalization.

These behaviors were coded by the 5-s one-zero time sampling method and the percentages of the occurrences were calculated for each condition.

2.4. Coding

The well-trained coders viewed video records of the 150-s procedure and coded each dependent measure by pressing a button on a computer keyboard. This activated the channel of a computerized event recorder.

2.5. Reliability

The videotapes were coded by graduate students previously trained by the first author until an inter-rater reliability of .75 or more (Cohen's kappa) was attained.

Twenty percent of the total number of sessions were selected at random and were coded independently by different coders. The reliability remained high across all the codes and conditions. The mean reliability coefficient was above .85 for each category.

3. Results

In order to examine developmental changes and sex differences in the percentages of infant positive and negative facial expressions, gaze directions, and vocalization, we conducted repeated measures analyses of variance (ANOVA) with age (4 and 9 months) and conditions (NI1, SF1, NI2, and SF2) as the within-subject factors, and infant sex (male and female) as the between-group factor. Tukey tests were used for post hoc analysis. Some of the coders failed to code all the behaviors because parts of the infants' bodies were invisible.

3.1. Infant positive facial expression

With regard to infant positive facial expression (Fig. 1), there were significant main effects of age ($F(1, 36) = 9.47, p < .01$) and condition ($F(3, 108) = 23.2, p < .01$). A significant interaction was found between age and condition ($F(3, 108) = 3.01, p < .05$). However, no sex differences were found. Furthermore, in order to examine patterns of change in infant positive facial expression across conditions, post hoc tests were conducted separately for each age.

Infants displayed positive facial expressions more frequently at 4 months than they did at 9 months. At both ages, infants showed higher levels of positive affect in the normal interaction conditions than they did in the SF conditions. Especially at 4 months, there were greater increases in the NI1 and NI2 conditions than 9 months. This implies that the positive affect of the infants at 4 months decreased when they encountered still-faced mothers, but returned in the NI2 condition more easily than it did at 9 months.

3.2. Infant negative facial expression

With regard to infant negative facial expression (Fig. 2), there were significant main effects of age ($F(1, 36) = 7.97, p < .01$) and condition ($F(3, 108) = 14.1, p < .01$). However, no significant interaction was found between any two variables, and there were no sex differences.

Infants displayed negative facial expressions more frequently at 4 months than they did at 9 months. At 4 months, infants showed negative facial expressions in SF1 and SF2 more frequently than they did in NI1 and NI2. At 9 months, however, infants responded more negatively in NI2 than they did in NI1; there was also a greater increase in the percentage of negative affect in SF2 than there was in SF1. These results imply that infants' distress increased gradually across conditions at 9 months, without recovering in the normal interaction after being exposed to their mothers' SF.

In sum, infants at 4 months displayed both negative and positive expressions more frequently than they did at 9 months, and developmental change was also found in the pattern of emotional responses to their mothers' SF.

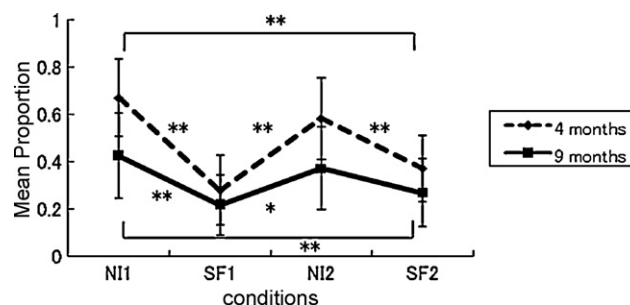


Fig. 1. Mean proportion and standard deviation of infant positive facial expression. ** $p < .01$; * $p < .05$.

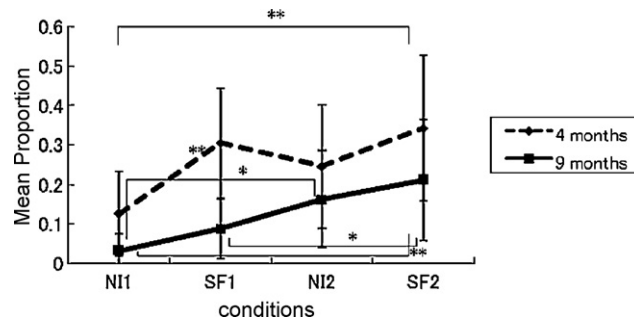


Fig. 2. Mean proportion and standard deviation of infant negative facial expression. ** $p < .01$; * $p < .05$.

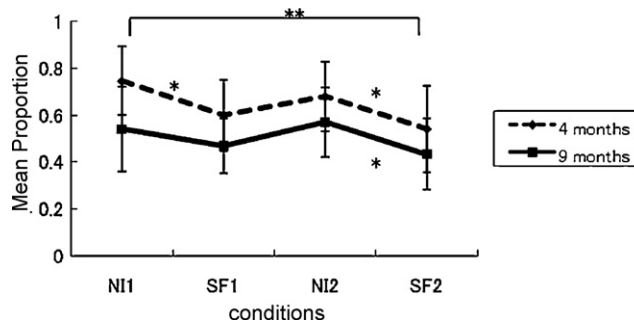


Fig. 3. Mean proportion and standard deviation of infant gaze at mother. ** $p < .01$; * $p < .05$.

3.3. Infant gaze at mother

With regard to infant gaze at mother (Fig. 3), there were significant main effects of age ($F(1, 40) = 5.53, p < .05$) and condition ($F(3, 120) = 8.57, p < .01$). No significant interaction was found between any two variables. There were also no sex differences. Infants gazed at their mothers more frequently at 4 months than they did at 9 months. Infants at 4 months gazed at their mothers less in the two SF situations. At 9 months, however, infant gaze decreased only in the SF2. It is notable that the significance was found only between NI2 and SF2 at 9 months.

3.4. Infant vocalization

With regard to infant vocalization (Fig. 4), there was no significant main effect of age; however, there was a significant main effect of condition ($F(3, 132) = 11.1, p < .01$) as well as a significant interaction between age and condition ($F(3, 132) = 13.5, p < .01$). No sex differences were found.

There were differences in patterns of change between the two infant ages across conditions. Although no significant difference was found across the conditions at 4 months, at 9 months the infants vocalized more often in the SF1 and SF2 conditions than they did in the normal interaction conditions. In other words, 9-month-old vocalized according to changes in maternal responsiveness.

In summary, the results indicated that at 4 and 9 months, infants showed a decrease in the display of positive facial expressions and gazed less at their mothers during the SF conditions. At 4 months, infants displayed emotional expression

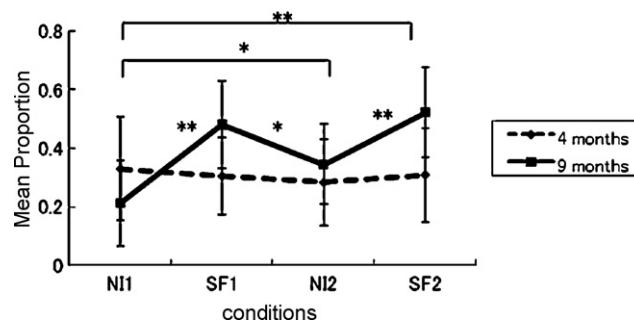


Fig. 4. Mean proportion and standard deviation of infant vocalization. ** $p < .01$; * $p < .05$.

and directed their gaze toward their mothers more frequently than they did at 9 months. However, at 9 months, the infants vocalized more often in the SF situations. Only at 9 months did the infants display more negative affect in the normal interaction after experiencing the SF situations. Sex differences were not found at either of the infant ages.

4. Discussion

4.1. Developmental changes in infant behavior

At both ages, infants showed higher levels of positive affect in the normal interaction conditions than they did in the SF conditions. Especially at 4 months, there were larger differences in infant behavior between the normal and SF conditions; i.e., at 4 months, the positive affect of the infants' experiencing SF1 decreased, but returned in NI2 more easily than it did at 9 months.

Furthermore, at 4 months, the infants showed negative affect in SF1 and SF2 more frequently than they did in NI1 and NI2. At 9 months, however, the infants responded more negatively in NI2 than they did in NI1. They also showed an increase in the percentage of negative affect in SF2, compared with the increase in negative affect in SF1.

From 4 months onward, infants develop sensitivity to social contingencies or sensitivity to what can be expected next in the behavior of an interacting and reciprocating social partner (Rochat & Striano, 1999). Therefore, infants at both ages were sensitive to the unresponsive faces and positive affect decreased during the two SF conditions in our study.

The results at 9 months are termed as the "carry-over" effect (Field, Vega-Lahr, Scafidi, & Goldstein, 1986; Fogel, Diamond, Langhorst, & Demos, 1982; Tronick et al., 1978), according to which, after experiencing their mother's SF, infants' distress increased gradually across conditions without recovering in the normal interaction.

Important changes occur during the first half year in infants' visual attention to faces, detection of facial features (Bushnell, 1979; Haith, Bergman, & Moore, 1977; Johnson, Dziurawiec, Ellis, & Morton, 1991), including gaze direction (Symons, Hains, & Muir, 1998) and facial expressions (Caron, Caron, & Myers, 1985; Ludemann & Nelson, 1988). The differential carry-over effect between two infant ages in our study might reflect the infants' developmental changes in social cognition including sensitivity to others' facial features and emotional expressions, as well as sensitivity to social expectations of maternal intervention to help regulate their negative affect.

However, some researchers have found a carry-over effect in only 2-month-old infants (Fogel et al., 1982), who cried more during the reunion episode than during the other conditions. Moreover, other researchers have not reported a continuation or increase of negative affect following the resumption of normal maternal interactive behavior (Gusella, Muir, & Tronick, 1988). Gusella et al. (1988) found no evidence that the reunion episode was as stressful as the SF at 3 and 6 months. Rather they found increases in gazing at the mother and positive affect. These results are, however, partly consistent with our findings that infants expressed not only negative affect but also positive affect when their mother resumed their interaction. One reason why infants showed so complicated facial expressions is that mothers, who felt uncomfortable being unresponsive during SF conditions, tried to interact with their infants more than usual as a way of apologizing in the reunion episode (Mayes, Carter, Egger, & Pajer, 1990). Variables of maternal behavior should be taken into analysis in any future study.

There were also obvious differences in patterns of change in infant vocalization between the two infant ages across conditions. Few differences were found across conditions at 4 months; however, infants at 9 months vocalized more in the SF conditions than they did in the normal interaction conditions.

These results indicate that 9-month-old vocalized according to the social context, i.e., mainly when their mothers were still-faced. They might be trying to solicit some sort of response from their still-faced mothers by vocalizing to them.

On the other hand, the percentages of infant positive and negative facial expressions decreased in all four conditions as the infants grew older. These results lead to the conclusion that the infants had acquired the social skills to express how they felt through vocalizations instead of expressing themselves through affect. This could be the precursor to lexical development in the beginning of the second year, and can be explained as the development of emotional self-regulation, which involves an appropriate level of emotional expression, and the development of coping strategies to deal with environmental stressors.

Almost all previous studies captured the still-face effect by coding infant direction of gaze and basic facial expressions; infant vocalization tends to be ignored or clustered into those coding categories (example, Tronick, Als, & Brazelton, 1980). Our results suggest that infant vocalization is effective as an index of the still-face effect, and that longitudinal research is needed for further study.

Gaze aversion from the still-faced partner can be explained as a mechanism for reducing arousal or tension and for processing stimulation received from one's social partner. Infants at both ages gazed less at their mothers in the SF conditions, and there were age differences in patterns of change across conditions. Furthermore, in both the normal and SF conditions, we found a developmental decrease in the percentage of times the infants gazed at their mothers. These findings are consistent with previous studies, which also found infants' developmental decrease in gazing at their mothers during face-to-face play (Cohn & Tronick, 1987) and during the SF situation (Gusella et al., 1988) when infants are compared at 3 and 6 months.

Younger infants have difficulty in disengaging fixation from salient central stimuli, and the ability to make large voluntary saccades is restricted (Hood, 1995). Infants gaze for longer periods of time at others' faces from the time they turn 2 months old; however, the duration of visual fixations decreases over the first year (Ruff & Rothbart, 1996) as infants' visual attention becomes fleeting. The time spent gazing at others' faces tends to decrease in duration from around 4 months (Rochat, Querido, & Striano, 1999). The infants in our study might become skillful in disengaging their attention and shifting to the

other stimuli more quickly at 9 months than they could at 4 months. Moreover, joint attention skills emerge at around 9 months (Tomasello, 1995). It is assumed that infants become more interested in external environments than they do in a familiar social partner. For 9-month-old, gaze aversion from their mothers may be related more to the redirection of infant attention and an increased interest in external environments (Adamson, 1996).

4.2. Sex differences

The ANOVA revealed no significant differences between male and female infants with regard to percentages of facial expressions, gaze, or vocalization.

As mentioned before, in previous studies, the results on sex differences with regard to the SF effect are inconsistent. These findings may reflect minor differences in experimental procedure and the way in which behaviors were coded.

Mayes and Carter (1990) pointed out that girls are more stressed by a SF than boys are because mothers are more likely to respond to girls' distress in a naturalistic interaction (Haviland, 1977; Lewis, 1972). Further investigations need to be conducted on sex differences in infants, utilizing the relationship with their caregiver (i.e., maternal sensitivity, attachment, or childrearing style) as variables.

4.3. Cultural differences

Our findings on infant facial expressions and gaze in the SF replicate previous work on the SF paradigm conducted in Western countries (Gusella et al., 1988; Tronick et al., 1978). Japanese infants tend to be less active, irritable, more easily soothed when upset, and better at calming themselves than Caucasian infants (Camras, Oster, Campos, Miyake, & Bradshaw, 1992; Caudill & Weinstein, 1969; Lewis, Ramsay, & Kawakami, 1993). Our findings serve as evidence for the validity of applying the SF procedure to Japanese infants, who are different in temperament and emotional responsiveness. These results suggest that the still-face effect might be an innate withdrawal response to a lack of contingent interaction. Considering that most cross-cultural studies on interactions between infants and caregivers have involved naturalistic observations, more experimental studies should be conducted across cultures hereafter.

More noteworthy is that our procedure confirmed the reliable effect on infant responsiveness, despite the fact that it was a much shorter procedure than the others in previous studies (Muir & Hains, 1993; Tronick et al., 1978), in which each episode lasts 2 or 3 min. Moreover, at both ages, few infants (8 out of 70 at the two infant ages) cried or fussed continuously in the SF condition. This result suggests that the maternal SF in our procedure is a mildly stressful situation, which minimizes the experimental distress of participants.

5. Conclusions

Our study revealed that there were developmental changes in the amount and pattern of infant responses to maternal SF. The results can be explained by the development of infant sensitivity to social stimuli and of the social skills to cope with an emotionally stressful situation during the first year of life.

The paradigm has been used with infants ranging in the age from 2 to 6 months (as a review, Adamson & Frick, 2003), probably because the responsiveness to the SF situation seems to become less obvious as children grow older. However, our study revealed that at 9 months, infant gaze, and negative affect had changed in the SF2, which suggests the effectiveness of exposing older children to another SF condition after the reengagement condition.

Our study also supports the importance of focusing not only on the SF periods but also on the reengagement periods, which enables us to observe the infant's ability to recover from an emotionally distressing situation. In future studies, it would be worthwhile to investigate the relationship between infants' SF responsiveness in the first year of life and emotional self-regulation in later life.

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Appendix A. Appendix A

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