Infant Affective Reactions to the Resumption of Maternal Interaction after the Still-Face

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WEINBERG, M. KATHERINE, and TRONICK, EDWARD Z. *Infant Affective Reactions to the Resumption of Maternal Interaction after the Still-Face.* CHILD DEVELOPMENT, 1996, 67, 905–914. To investigate infants' reactions to the Face-to-Face Still-Face Paradigm and in particular the reunion episode, 50 6-month-olds' affective, behavioral, and physiologic reactions were recorded and analyzed. Infants reacted to the still-face with negative affect, a drop in vagal tone, and an increase in heart rate. By contrast, they reacted to the reunion episode with a mixed pattern of positive and negative affect. There was a carryover of negative affect from the still-face, an increase in fussiness and crying, and a rebound of positive affect. During this episode, the infants' heart rate and vagal tone returned to initial levels. The data indicate that infant affective displays are specifically related to different interactive events, but that their physiologic reactions do not show the same level of specificity. The findings also highlight the complexity of the affective and reparatory processes that take place in mother-infant interactions.

The Face-to-Face Still-Face Paradigm has been used extensively to evaluate young infants' communicative abilities, sensitivity to changes in maternal behavior, and capacity to regulate affective states (Tronick, 1989). The paradigm confronts the infant with three age-appropriate conditions: (1) a face-to-face social interaction with the mother; (2) a still-face episode during which the mother assumes a still or poker face and remains unresponsive to the infant; and (3) a reunion episode of face-to-face social interaction with the mother. Each episode typically lasts 2 or 3 min, and the paradigm has been used with infants ranging in age from 2 to 9 months (see, e.g., Toda & Fogel, 1993; Weinberg & Tronick, 1994).

Most research on the paradigm has focused on the still-face episode. During this episode, mothers are asked to assume a still, neutral face, to look at the infant, but not touch or talk to the infant. As described by Tronick (Tronick, Als, Adamson, Wise, & Brazelton, 1978; see also Carpenter, Tecce, Stechler, & Friedman, 1970) in the study that originated the paradigm and as replicated in several other projects (Field, Vega-Lahr, Scafidi, & Goldstein, 1986; Fogel, Diamond, Langhorst, & Demos, 1982; Gusella, Muir, & Tronick, 1988; Mayes & Carter, 1990; Stack & Muir, 1990, 1992; Stoller & Field, 1982; Toda & Fogel, 1993), infants typically respond to the still-face episode as contrasted to the first play episode with decreases in smiling and gazing at the mother and increases in motor activity; touching and grasping of the self, clothing, or chair; withdrawal; and, according to some but not all reports, an increase in negative affective facial and vocal displays including grimaces, distress brows, and crying.

A number of interpretations have been advanced to account for the still-face effect. One interpretation is that the still-faced mother violates the infant's expectation for a normal interaction (Field et al., 1986; Tronick et al., 1978) or is behaving in a manner too discrepant from the infant's schema of her normal behavior (McCall & Kagan, 1967). Another interpretation is that by withdrawing all forms of contact with the infant, the mother no longer provides the infant with the regulatory input necessary to maintain an organized social and affective state (Stack & Muir, 1990). Research by Muir (Gusella et al., 1988; Stack & Muir, 1990, 1992)

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demonstrates that if the mother is allowed to touch the infant during the still-face, the infant's negative reaction is attenuated. Alternatively, Tronick (1980, 1989) has proposed that the mother's lack of responsiveness disrupts the infant's goal for social engagement. This disruption generates negative emotional states along with attempts by the infant to regulate these states by disengaging and utilizing self-comforting behaviors. This explanation argues that the infant has a goal for relating to people and that when there are obstacles to the achievement of this goal the infant is stressed and negative emotional states are generated (Trevarthen, 1977).

The reunion episode of normal interaction, which follows the still-face, has received scant attention in the literature. This is unfortunate because this episode may highlight the affective and dyadic regulatory processes that take place in the mother-infant interaction. Tronick and Cohn (1989; see also Beebe & Lachmann, 1994) have described normal mother-infant interactions as characterized by numerous interactive errors or mismatches that are quickly repaired. The interaction moves rapidly from coordinated to miscoordinated states and back again. During the reunion episode the mother and infant must repair the interaction following a prolonged interactive error (i.e., the still-face). The reunion episode therefore presents the infant with an affectively complex and demanding regulatory task. The infant must simultaneously cope with the resumption of maternal behavior (in all likelihood a positive event for the infant) and cope with the intra- and interpersonal carryover of negative affect from the still-face. We would expect that these conflicting demands would be expressed in a mixed pattern of positive and negative affective displays that may not be observed in interactions that are not preceded by an interactive disturbance.

The data available in the literature support the perspective that the reunion episode elicits a mixed affective reaction in young infants. Several researchers have described a carryover of negative affect from the still-face to this episode (Field et al., 1986; Fogel et al., 1982; Tronick et al., 1978). For example, in the original paper using the Face-to-Face Still-Face Paradigm, Tronick (Tronick et al., 1978) reported that infants show an initial period of wary monitoring and anger when the mother first resumes normal interactive behavior, which is occasionally followed by the infant arching his or her back away from the mother "as if he had not forgiven her the previous insult" (p. 10). Field (Field et al., 1986) further found that infants show distress after the resumption of maternal behavior. She reported that infant motor activity, distress brow, and crying increased during the still-face episode and remained high during the reunion episode. Similarly, Fogel found that infants cried more during the reunion episode than during the other two conditions (Fogel et al., 1982; Toda & Fogel, 1993) and smiled less during the reunion episode than in the first play (Fogel et al., 1982). Other researchers, however, have not reported a continuation or increase of affectively negative displays following the resumption of normal maternal interactive behavior. Gusella, Muir, and Tronick (1988) found no evidence that the reunion episode was as or more stressful than the still-face. Rather they found increases in infant looking and smiling at the mother during the reunion episode. These findings in the literature are consistent with an interpretation that infants experience both positive and negative affective reactions when their mother resumes interactive behavior.

In this study, we microanalytically examined the differential distribution of 6-month-old infants' affective reactions to the episodes of the Face-to-Face Still-Face Paradigm. In particular, we were interested in evaluating the nature of the infants' reaction to the reunion episode. Most of the previous work on the Face-to-Face Still-Face Paradigm, though microanalytic, has coded a priori clusters of behaviors (e.g., Monadic Phases; see Tronick, Als, & Brazelton, 1980) that have typically grouped facial expressions with other behaviors. In this study, we coded infant facial expressions with Izard's AFFEX system (Izard & Dougherty, 1980) separately from the infants' other behaviors (i.e., direction of gaze, vocalizations, gestures, self-comforting, withdrawal, and autonomic stress indicators), which were coded with the Infant Regulatory Scoring System (IRSS; Tronick & Weinberg, 1990). Many of these IRSS displays, and in particular AFFEX-coded facial expressions, have not been previously examined in this paradigm. Additionally, the infants' autonomic reactivity as indexed by heart rate and vagal tone was assessed during the episodes of the Face-to-Face Still-Face Paradigm. It was expected that the still-face episode in particular would be an effective stressor that would

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elicit increases in heart rate and decreases in vagal tone in the infants. With a few exceptions (e.g., Stoller & Field, 1982), measures of heart rate and vagal tone have not typically been employed in this paradigm.

Based on previous work (Weinberg & Tronick, 1994), we expected that there would be specific relations between the AFFEX-coded facial expressions, IRSS-coded behaviors, and physiologic measures and each of the episodes of the Face-to-Face Still-Face Paradigm. In particular, we hypothesized that in the reunion episode infants would display a mixed pattern of positive and negative affective displays that would not be observed in the other two episodes, and that vagal tone and heart rate would reflect the predominant affective state (as indexed by both AFFEX and IRSS codes) associated with each of the episodes of the paradigm.

In this study, AFFEX was used as a method for coding facial expressions. It is important to note from the outset that we do not equate a particular IRSS behavioral modality or AFFEX facial expression with a specific infant emotion. Although AFFEX codes label facial expressions with emotion terms such as joy or anger and equate facial expressions with discrete emotions (Izard, 1977; Izard & Malatesta, 1987), it is our perspective that facial expressions do not constitute the primary index of affective states. Rather, infant affective states are best characterized as coherent configurations of facial expressions and behaviors (Weinberg & Tronick, 1994; see also Fogel et al., 1992). These affective configurations serve both a regulatory and communicative role within a social context. Therefore, in this article, terms such as affect, affective displays, or affective state are conceptualized as indexed by both facial expressions as coded by AFFEX and behaviors as coded by the IRSS.

Method

Subjects

The data from 25 male and 25 female 6-month-old infants and their mothers randomly selected from a larger longitudinal study were analyzed. The infants ranged in age from 5 months 3 weeks to 6 months 1 week. All infants were full-term and healthy both at birth and at the time of the assessment. Mothers were married, Caucasian, had at least a high school degree (mean years of education = 14.62 years), were middle class (average Hollingshead Four-Factor Index for SES = 2.68), and ranged in age from 20 to 39 years (mean maternal age = 29 years). Forty-two percent of the mothers were primiparous. Subjects were recruited through birth announcements published in local newspapers and scheduled at a time when mothers judged their infants to be alert and rested.

Laboratory Setting and Procedures

The laboratory setting and procedures were based on those originally developed by Tronick (Tronick et al., 1978) and are described in detail elsewhere (Weinberg & Tronick, 1994). The video room was equipped with an infant seat mounted on a table, an adjustable swivel stool for the mother, two cameras (one focused on the infant, the other on the mother), a microphone, and an intercom via which mothers were given procedural instructions.

A cardiotachometer was also located in the video room. One cable ran from the amplifying device to the back of the infant seat. Leads from the electrodes attached to the infant were connected into this cable when the infant was placed in the infant seat. A second cable ran from the cardiotachometer to the second stereo channel of the videorecorder in order to record the heart rate and time lock it to the videorecording of behavior.

After obtaining informed written consent and information on family demographics, infant perinatal status, and general health, mothers and infants were videotaped in the Face-to-Face Still-Face Paradigm. The paradigm included a 2-min face-to-face normal interaction for which the mother was simply instructed to play with the infant, followed by a 2-min still-face interaction for which the mother was instructed to keep a poker or still face and to look at the infant but not to smile, talk, or touch the infant, and a second 2-min normal reunion interaction. The episodes were separated by 15-sec intertrial intervals during which the mother turned her back to the infant. Picture signals from the two cameras were transmitted through a digital timer and split-screen generator into a single videorecorder in order to produce simultaneous frontal views of the mother's face, hands, and torso and the infant's entire body.

Coding of Data

Coding of behavior and facial expressions.—The infants' facial expressions were scored using Izard's AFFEX system (Izard & Dougherty, 1980), which identifies 10 facial

expressions (i.e., joy, interest, sadness, anger, surprise, contempt, fear, shame/shyness/guilt, distress, and disgust) as well as blends of facial expressions. The infants' behavior was coded using the Infant Regulatory Scoring System (IRSS; Tronick & Weinberg, 1990; see Weinberg & Tronick, 1994, for details). This system codes the infant's direction of gaze (look at mother, look at objects, and scans),[1] vocalizations (neutral/positive, fussy, and crying), pick-me-up gestures, other gestural signals (one hand pointing or reaching toward mother, leaning toward mother, touching the mother), self-comforting (mouthing a body part or object), distancing (escaping by turning and twisting in seat), and autonomic stress indicators (spitting up, hiccuping). The gaze and vocalization codes are mutually exclusive, whereas the other codes can co-occur. Furthermore, it should be noted that mothers are instructed not to use toys or pacifying objects during the Face-to-Face Still-Face Paradigm. Therefore, the code of look at objects refers to the infant looking at objects inherent to the face-to-face setting, such as the infant chair or strap, or the infant's or mother's clothing.

The coding was done by several coders from videotapes using 1-sec time intervals. One coder scored the infants' direction of gaze, another vocalizations and gestures, and a third self-comforting, distancing, and autonomic stress indicators. In addition, two coders, who had been trained with Izard's training tapes and manuals, coded the infants' AFFEX facial expressions independently of the IRSS codes. A digital time display was used to track the intervals. This produced an absolute frequency count of the behaviors and facial expressions and maintained their temporal sequence to within a 1-sec interval. Tapes were run at normal speed, although they were frequently stopped or run in slow motion to accurately determine the beginning and ending of shifts in infant behavior.

Coders were aware of the face-to-face conditions. Although it would have been possible to mask the mother's side of the screen, this approach was not used because coders were able to track the conditions by looking at the time display recorded on the tapes. Furthermore, although in the majority of codes the tapes were coded with the sound off, coders scoring infant vocalizations and autonomic stress indicators were able to track the conditions by listening to the mothers' vocalizations. Coders, however, were unaware of the study's hypotheses. Furthermore, as noted by Melson and Fogel (1982), the independent multiple coder approach employed in this study is unlikely to result in consistent bias. Frequent interrater reliability checks also ensured that coders remained unbiased and reliable.

Reliability.—To assess interobserver reliability, 20% of the first play, still-face, and reunion episodes were selected randomly and recoded independently by a different coder. Reliability was determined in two ways. First, following the procedure established by Cohn and Tronick (1987), agreement was defined as both coders scoring the same IRSS or AFFEX code in the same 1-sec interval. This is an extremely stringent criterion requiring agreement by code and time. For example, lack of agreement can occur because the two coders code different behaviors or facial expressions in the same second or because they chose the same code but disagreed as to the exact second in which it occurred. Reliability was calculated using the formula agreements/(agreements + disagreements). The number of times both coders agreed a code did *not* occur, a number likely to inflate the agreement, was not considered in this calculation. Reliability was calculated for each IRSS code and for the AFFEX codes of joy, interest, sadness, and anger. The AFFEX-coded facial expressions of surprise, fear, disgust, distress, contempt, shame, and positive and negative blends occurred 1% of the time or less and were excluded from analysis. Mean agreement for each IRSS and AFFEX code is presented in Tables 1 and 2. Second, Cohen's kappas (Cohen, 1960; see also Cicchetti & Feinstein, 1990), a statistic that corrects for chance agreement, were calculated for categories with mutually exclusive codes (i.e., AFFEX facial expressions, gaze, and vocalizations). Mean kappas for AFFEX facial expressions, gaze, and vocalizations were .77, .82, and .76, respectively. These kappas are similar to those reported by other researchers (Toda & Fogel, 1993).

Coding of heart rate.—The analog ECG signal (from the audio channel of the videotape) was fed into a custom designed inter-

[1] Looking at objects was coded if the infant looked at an object for 2 sec or more. This coding criterion was used in order to distinguish between sustained object engagement and scanning of the environment, which was defined as looking at something for less than 2 sec.

TABLE 1

MEAN PROPORTIONS (MP), STANDARD DEVIATIONS (SD), AND NUMBER OF INFANTS (*N*) WHO DISPLAYED THE AFFEX-CODED FACIAL EXPRESSIONS OF JOY, INTEREST, SADNESS, AND ANGER DURING PLAY 1, THE STILL-FACE, AND REUNION PLAY

	PLAY 1			STILL-FACE			REUNION PLAY			
FACIAL EXPRESSION	MP	SD	*N*	MP	SD	*N*	MP	SD	*N*	*F*
Joy (.89)	.26a	.22	45	.06b	.09	37	.32c	.25	47	39.32**
Interest (.95)	.61a	.22	50	.72b	.24	50	.51c	.25	50	17.33**
Sadness (.82)	.00a	.01	8	.05b	.11	22	.03b	.06	22	6.33*
Anger (.89)	.02a	.07	16	.07b	.17	28	.07b	.15	22	3.91*

NOTE —AFFEX codes are mutually exclusive. Mean interrater reliability for each AFFEX code is in parentheses. Mean proportions with different letters differ significantly at $p < .05$.

* $p < .05$.

** $p < .01$.

face box. This interface box electronically calculated the time between adjacent R-waves of ECG and generated a signal whose voltage was proportional to the inter-R-wave interval. This signal was then digitized by computer (using a DataTranslation DT2821 A/D board) and reconverted into inter-beat-interval (IBI) values measured in milliseconds. Sequential IBIs were used to calculate heart rate (HR) values. The HR values were then analyzed with MXEdit Vagal Tone (VT) Software, and VT estimates were computed for 10-sec epochs across the entire duration of each of the episodes of the Face-to-Face Still-Face Paradigm (for details see Lester et al., 1990).

Internal Validity and Manipulation Check

Following Cohn and Elmore (1988) and Toda and Fogel (1993), a manipulation check was carried out on the mothers' behavior during the still-face episode to determine whether the mothers complied with the instructions for maintaining a still-face. Eighteen mothers smiled during the still-face for a total of 108 sec or a total of 1.8% of all the still-face data. As in Toda and Fogel's study, these smiles lasted an average of 6 sec. Furthermore, as in Cohn and Elmore's work, the percentage of time that the mothers smiled during the still-face was significantly less than in the Play 1 or reunion episodes (see Table 1). These results dem-

TABLE 2

MEAN PROPORTIONS (MP), STANDARD DEVIATIONS (SD), AND NUMBER OF INFANTS (*N*) WHO DISPLAYED EACH IRSS-CODED BEHAVIOR DURING PLAY 1, THE STILL-FACE, AND REUNION PLAY

	PLAY 1			STILL-FACE			REUNION PLAY			
BEHAVIOR	MP	SD	*N*	MP	SD	*N*	MP	SD	*N*	*F*
Look at Mother (.87)	.39a	.25	50	.24b	.15	50	.53c	.25	50	33.41**
Look at Objects (.96)	.42a	.23	50	.50a	.21	50	.30b	.24	46	14.43**
Scans (.92)	.19a	.11	50	.24b	.12	50	.14c	.10	50	14.63**
Neutral/Positive Vocalizations (.75)	.08a	.13	42	.05a	.06	37	.18b	.19	43	21.58**
Fussy Vocalizations (.81)	.05a	.11	19	.07a	.13	21	.10b	.14	31	3.85*
Crying (.77)	.00a	.01	1	.01a	.04	3	.06b	.20	7	5.08*
Pick-Me-Up Gesture (.77)	.01a	.03	5	.04b	.07	22	.04b	.10	12	3.96*
Gestural Signals (.77)	.15a	.19	41	.09a	.11	42	.28b	.23	48	19.87**
Mouthing Body Part (1.00)	.04	.09	15	.02	.06	19	.05	.13	17	2.37
Mouthing Object (.96)	.05	.10	18	.03	.08	15	.04	.08	19	1.03
Distancing/Escape (.91)	.01a	.03	12	.03b	.08	19	.03b	.08	15	3.18*
Autonomic Stress Indicators (.80)	.01a	.03	13	.04b	.08	21	.03b	.08	16	3.28*

NOTE —The categories Look at Mother, Look at Objects, and Scans are mutually exclusive. The other behavioral categories can co-occur with Look at Mother, Look at Objects, and Scans, and with each other. Mean interrater reliability for each IRSS code is in parentheses. Mean proportions with different letters differ significantly at $p < .05$.

* $p < .05$.

** $p < .01$.

onstrate the effectiveness of the still-face manipulation.

Results

Specificity of AFFEX-Coded Facial Expressions by Condition

To evaluate the specificity of the AFFEX-coded facial expressions and IRSS-coded behaviors by condition, a repeated-measures, one-way ANOVA with episodes as repeated measures was carried out. Post-hoc tests were further used to explore significant findings. As can be seen in Table 1, there were main effects of episode for the AFFEX facial expressions of joy, interest, sadness, and anger. Facial expressions of joy occurred significantly more during the two play episodes than during the still-face and significantly more during the reunion episode than the first play. Facial expressions of interest occurred frequently in all three conditions but were most likely to occur during the still-face. Facial expressions of sadness and anger were unlikely to occur during the first play. Sad and angry facial expressions, however, increased significantly in the still-face and remained at this higher level during the reunion episode. There was no significant difference in the incidence of sadness and anger facial expressions during the still-face and reunion episodes. These data indicate that infants inhibit facial expressions of joy and display facial expressions of sadness and anger when their mothers act in an unresponsive manner. The data further indicate that they respond with a rebounding of facial expressions of joy above the "baseline" level of the first play episode but not a decrease in facial expressions of sadness and anger when the mothers resume normal interactive behavior.

Specificity of IRSS-coded Behaviors by Condition

Nearly all the IRSS-coded behaviors, including the different types of gaze, vocalizations, gestures, distancing, and autonomic stress indicators, were differentially distributed among the conditions of play 1, still-face, and reunion (see Table 2). In terms of gaze, the infants were least likely to look at the mother during the still-face and most likely to look at her during the reunion episode. The infants were equally likely to look at objects during the first play and still-face episodes. The incidence of looking at objects, however, dropped significantly during the reunion episode. Finally, the infants were most likely to scan during the still-face and least likely to scan during the reunion episode. Thus the infants looked less at the mother during the still-face and spent a considerable amount of time looking at objects and scanning. During the reunion episode, there was a rebound of looking at the mother above the "baseline" level observed in the first play. At the same time, looking at objects and scanning decreased to their lowest levels.

The infants displayed more IRSS-coded behaviors communicating a negative evaluation of the interaction in the reunion episode than in the other two episodes. Fussy vocalizations and crying were most likely to occur during the reunion episode. Furthermore, pick-me-up gestures, attempts at physically distancing the self by turning and twisting in the seat, and autonomic stress indicators were unlikely to occur during the first play, but increased significantly during the still-face and remained at this higher level during the reunion episode. There were no significant differences in the incidence of these behaviors during the still-face and reunion episodes.

The infants also displayed more IRSS-coded behaviors communicating a positive evaluation of the interaction in the reunion episode than in the other two episodes. Neutral/positive vocalizations and gestures other than pick-me-ups were significantly more likely to occur during the reunion episode than during either the first play or the still-face. Neutral/positive vocalizations and gestures were equally likely to occur during the first play and the still-face. These data indicate that the infants displayed a mixed pattern of positive and negative IRSS-coded behaviors during the reunion episode that was not observed in either the first play or the still-face.

Specificity of Heart Rate by Condition

To evaluate the specificity of heart rate and vagal tone by condition, a repeated-measures, one-way ANOVA with episodes as repeated measures was carried out. The results demonstrated main effects for both heart rate ($F = 43.26$, $df = 88,2$) and vagal tone ($F = 10.67$, $df = 88,2$) by episode. Specifically, as shown in Table 3, heart rate was significantly higher and vagal tone was significantly lower in the still-face episode than in either the first play or reunion episodes, which did not differ from one another.

Discussion

The hypothesis that there would be specific relations between the infants' affective

TABLE 3

HEART RATE AND VAGAL TONE BY EPISODES OF THE FACE-TO-FACE STILL-FACE PARADIGM

	Play 1	Still-Face	Reunion Play
Heart rate	138.20a	143.88b	139.91a
Vagal tone	3.165a	3.034b	3.237a

NOTE —Mean values with the same letter do not differ significantly ($p < .05$) from one another using the Duncan Range Test. The critical ranges for the heart rate and vagal tone data were 1.243 and .0889, respectively.

displays measured by AFFEX facial expressions and IRSS behaviors and the episodes of the Face-to-Face Still-Face Paradigm was supported. The infants' affective displays were specifically related to the interactive event the infant was experiencing. During the first play episode, the infants were generally positive and showed little negative affect. During the still-face episode, as compared to the first play episode, the infants displayed significantly fewer facial expressions of joy and looked less at their mother. They also showed significantly more facial expressions of interest. This is consistent with research by Toda and Fogel (1993) showing that 6-month-old infants react to the still-face with reduced smiling and gazing at the mother and increases in neutral facial expressions. The infants also showed significantly more affective displays communicating a negative evaluation of the mothers' behavior during the still-face than the first play. Facial expressions of sadness and anger, scanning, pick-me-up gestures, distancing by twisting and turning in the seat, and autonomic stress indicators such as hiccuping and spitting up were more likely to occur during this episode than during the first play. These data suggest that infants react negatively to their mother posing the still-face, although there is relatively little fussing and crying. Furthermore, the configuration of increased facial expressions of interest, decreased looking at the mother, and high level of object engagement suggests that focusing attention at something other than the mother may be a form of distraction, coping, and emotional regulation employed by the infants during the still-face (Brazelton, Koslowski, & Main, 1974; Gianino & Tronick, 1988).

During the reunion episode, the infants showed a different pattern of responses than during the still-face. On the one hand, the reunion episode, like the still-face, was characterized by negative affective displays. The infants continued to show facial expressions of sadness and anger, pick-me-up gestures, distancing, and autonomic stress indicators at levels not significantly different from those observed in the still-face. The infants were also significantly more likely to fuss and cry in the reunion episode than in the still-face. These data are consistent with the interpretation in the literature of a carryover effect of negative affect from the still-face to the reunion episode and indicate that infant negative affective states are not easily assuaged by the resumption of maternal interactive behavior (Field et al., 1986; Fogel et al., 1982; Tronick et al., 1978). It is also possible that the increase in fussiness and crying reflects the infants' expectation of maternal intervention to help regulate their negative affect.

On the other hand, the reunion episode, unlike the still-face, was also characterized by positive affect. There was a rebound of positive mother-oriented behaviors to levels even higher than those observed in the first play. Facial expressions of joy, looking at the mother, neutral/positive vocalizations, and gestural signals directed toward the mother were all significantly more likely to occur during this episode than during either the first play or the still-face. Moreover, the infants were least likely to look at objects and scan the laboratory environment during the reunion episode. These data are consistent with an interpretation that the infants welcomed the resumption of maternal interactive behavior.

These findings highlight the importance of the reunion episode as a critical but much neglected component of the Face-to-Face Still-Face Paradigm. The hypothesis that infants would display a mixed pattern of positive and negative affective displays during the reunion episode that would not be observed in the other two episodes was supported. The reunion episode was character-

ized by a carryover of negative affect from the still-face, an increase in fussiness and crying, and a rebound of positive affect. Why might this emotional complexity manifest itself in this episode in particular? One possibility is that maternal behavior was responsible for the infants' reaction to the reunion episode. Mayes (Mayes, Carter, Egger, & Pajer, 1990) has suggested that some mothers may not resume their usual interactive style after the still-face. She found that mothers who felt uncomfortable during the still-face returned to the interaction with more soothing comments. In previous research, however, we found few changes in maternal behavior between the first play and reunion episodes (Weinberg, 1992). Further examination of this issue is needed.

Alternatively, the complexity of the infant's reaction to the reunion episode may reflect the affective and dyadic regulatory processes that take place in the mother-infant interaction. Tronick and Cohn (1989) have characterized normal interactions as a sequence of dyadic matching states associated with positive affect and mismatching states associated with negative affect. The process of transforming mismatching states into matching states has been labeled interactive reparation. From this perspective, infants experience positive and negative affect even during well-coordinated interactions. However, the predominant affect is positive given the mother-infant dyad's capacity for interactive reparation. During the still-face, the infant is faced with an irreparable interactive error. Even after attempts to change maternal behavior and repair the interaction, the mother remains unresponsive. The interactive error continues, the reparation fails, and, as a result, infant negative affect predominates. By contrast, in the reunion episode, the mother and infant can begin the process of reparation, which, if successful, leads to positive affect. However, infant negative affect is not easily assuaged during the reunion episode because carryover effects from the still-face make reparation difficult. This difficult process of reparation is indicated by the high incidence of fussing and crying at levels higher than those observed in the first play or the still-face. Thus the complexity of the infants' affective experience in the reunion episode reflects the dyads' attempt to renegotiate their typical interaction and to cope with the negative intra- and interpersonal aftermath of the still-face.

Relatedly, one could speculate that the reunion episode arouses an emotional ambivalence in the infant. It is possible that the infant has both a goal of repairing and resuming the interaction and a goal of withdrawing from the interaction as a result of the mother's behavior in the still-face. This emotional ambivalence is reminiscent of data reported by Campos, Emde, Gaensbauer, and Henderson (1975). They found that infants express the widest range of affective reactions and display the highest levels of smiling and sobering in response to the departure of a stranger. Campos's findings may be indicative of the infant's conflicting goals to both interact with and withdraw from the stranger.

The hypothesis that autonomic reactivity would reflect the predominant affective state associated with each of the episodes of the Face-to-Face Still-Face Paradigm was partially supported. The heart rate and vagal tone data confirm the stressful nature of the still-face episode. Heart rate went up and vagal tone went down during the still-face episode compared to the first play episode. This pattern of autonomic reactivity indicates that the infants experienced the still-face as stressful and conforms to the primarily negative affective displays observed during the still-face. The heart rate and vagal tone data during the reunion episode, however, are not so easily interpreted. During this episode, the infants' heart rate and vagal tone returned to the levels observed during the first play episode. Were the affective displays similar in the first play and reunion episodes, the data could be interpreted as the infants' heart rate and vagal tone returning to nonstressful levels. However, the AFFEX facial expressions and IRSS behaviors displayed by the infants were very different in these two episodes. In the first play, the infants were generally positive and showed little negative affect. In the reunion episode, the infants displayed a mixed pattern of both positive and negative affect.

One interpretation of these data is that expressed negative affect and autonomic measures may not be tightly coupled. Gunnar (Gunnar, Mangelsdorf, Larson, & Hertsgaard, 1989) found dissociations between behavioral and physiologic measures of stress. The data reported here are consistent with her interpretation that infants may not be as physiologically stressed as their affective displays suggest. Thus, the data indicate that, although the infants' affective displays are specifically related to different interactive events, their physiologic reactions do not show the same level of specific-

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ity. An alternative hypothesis is that positive infant affect in response to the resumption of maternal interactive behavior buffers the infant against lingering stress and negative affect, and that this buffering is indexed by a return to nonstressful levels in autonomic measures. In autonomic terms, this may represent a balancing of the regulatory input of the parasympathetic and sympathetic systems (J. Kagan, personal communication). This balancing would be consistent with the hypothesis that infants experience strong ambivalent emotions during the reunion episode.

In sum, the infants' reactions to the episodes of the Face-to-Face Still-Face Paradigm evidence specificity as well as complexity in relation to the communicative and interactive context of each episode. This complexity is interpretable in terms of the meaning of the events to the infant and the communicative interactive process context in which they are embedded. Thus, as we have argued elsewhere (Weinberg & Tronick, 1994; see also Fogel et al., 1992; Trevarthen, 1977), the infants' affective displays form configurations that are related to the infants' affective states and to interactive contexts.

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