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Direction of Regard and the Still-Face Effect in the First Year: Does Intention Matter?

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In the first study, 3-, 6-, and 9- month-olds' behavior was assessed as a stranger broke contact to stare at the infant, to look at a wall, or to look at another person. Regardless of age and the reason contact was broken, the still-face reaction did not depend on the experimenter's intention. In the second study, 3-, 6-, and 9-month-olds interacted with their mother who broke contact to look away for no apparent reason or in the direction of a sound. Infants at all ages responded to the still-face episode, but not as a function of the underlying reason contact was broken. The findings suggest a primacy of interpersonal communication in the first year.

The human infant is born predisposed to communicate, reciprocate, and connect with other people (Trevarthen, 1979). From the start, infants distinguish between the social and nonsocial world (e.g., von Hofsten & Roennqvist, 1993) and manifest signs of intersubjectivity and social attunement (Kugiumutzakis, 1998; Stern, 1985; Trevarthen, 1979). Over the first months, infants develop expectations about people as they interact with them (e.g., Bigelow, 1998; Meltzoff & Moore, 1992). One of the most robust phenomena suggesting that young human infants expect people to behave in certain ways is the negative response caused by the sudden still face adopted by a social partner in a face-to-face interaction (Field, Vega-Lahr, Goldstein, & Scafidi, 1986; Tronick, Als, Adamson, Wise, & Brazelton, 1978). As early as 3 months of age, infants are more upset when a person compared to an object becomes unresponsive (Ellsworth, Muir, & Hains, 1993). Although the early reaction to the still face is robust and selective in nature, the traditional paradigm does not provide much insight as to infants' understanding of the motive or the underlying reason interpersonal contact was broken. The developmental origin of such understanding is significant in relation to our understanding of human ontogeny because one of the most significant and unique aspects of human cognition is the inclination to probe and consider others' minds (i.e., theory of mind; Tomasello, 2000; Wellman, 1993).

Many questions remain regarding how and when an understanding of internal mental states develops in early ontogeny. There is much debate over whether an understanding of motives or intentionality in the behavior of people might already be present at birth (Trevarthen, 1979) or whether it emerges only later in ontogeny via processes of simulation (Tomasello, 1995) or associative learning (Moore & Corkum, 1995). Toward the end of the first year, infants systematically engage in a variety of joint-attention behaviors such as gaze following, social referencing, and communicative gestures that are not readily observed in the months prior (e.g., Carpenter, Nagell, & Tomasello, 1998). Together, the coalescence of these behaviors are thought by some to index the infants' understanding of intentions in others (Tomasello, 1995).

It is not generally noted, however, that along with many developments involving the more systematic coordination of attention come changes in the nature of face-to-face contact between infants and caregivers (Striano, 2001). Cohn and Tronick (1987), for instance, examined the sequential structure of face-to-face interactions between mother–infant dyads at 3, 6, and 9 months of age. The authors found that mothers systematically initiated positive emotional

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displays with 3- and 6-month-old infants. However, by 9 months of age, infants displayed social initiatives in interaction. In the context of normal interactions, they were more likely to smile before their mothers did. Thus, considering the development of face-to-face competencies over early ontogeny is one method of revealing the development of infants' understanding of others' intentions before 9 months of age. Few studies have considered the potential link between infants' early dyadic and triadic social skills (however, see Tremblay-Leveau & Nadel, 1996, with 11- and 23-month-olds; Striano & Rochat, 1999).

It is possible that before the end of the first year, infants manifest an awareness of intersubjective intentions, or the attentional states or affects that provide cues to these intentions. Accordingly, if the human infant expresses a nascent understanding of intentions, such understanding should be observable in the early months once they more systematically engage and reciprocate in the context of dyadic interactions (Rochat & Striano, 1999; Stern, 1985).

To assess such idea, Murray and Trevarthen (1985) used a modified still-face paradigm to assess what young infants understand about people's communicative intentions. Mothers interacted with their 2- to 3-month-old infants in a 30-s positive face-to-face interplay that was suddenly halted with two different kinds of ''breaks of contact'' (p. 181). In the interruption condition, the mother turned away from the infant for 30 s, looking over her shoulder to talk to an experimenter who entered the room. In the blank-face condition, the mother posed a neutral still face while continuing to look at her infant and without having the experimenter in the room. When the experimenter suddenly interrupted their mother, infants maintained a relaxed expression. In contrast, when mothers posed a blank face, infants began to engage in self-comforting behaviors and reduced positive affect such as gazing and smiling. The authors concluded that by 2 to 3 months of age, infants understand the interpersonal and emotional value of others' social behavior. However, before firm conclusions can be made, appropriate controls are needed. For instance, the position of the mother's face was not controlled in Murray and Trevarthen's study.

Given infants' early sensitivity to eye-to-eye contact (e.g., Hains & Muir, 1996b; Haith, Bergman, & Moore, 1997), it is possible that infants were using the mothers' eyes as a signal for communication in the blank-face condition and were simply distressed when contact could not be reestablished. Such ability would imply the use of the eyes as a cue to communication but would not imply an appreciation of the underlying mental state or the underlying intent of the person. An additional confound may have been the entry of the person entering the room and the fact that the mother spoke to the person in one condition (interruption condition) but not in the other. Infants may also have been less distressed in this situation because they could observe their mother talking and were attracted by the mere presence or absence of such stimuli. Furthermore, the small sample size ($N = 8$ infants between 6 and 12 weeks of age) of the study limited its generalizability.

These interpretations can be ruled out by having the interactive partner's behavior remain constant and by controlling only the reason contact is broken. Furthermore, the interpretation would be even more convincing if older infants manifested the same response. Accordingly, if infants appreciate interpersonal intentions from the start, their behavior should not reliably depart from that of older infants. Despite a more expansive behavioral repertoire, their underlying understanding of interpersonal intention and in particular their motive for communication should not differ from that of 2- to 3-month-olds. On the contrary, if infants' awareness of other people undergoes dramatic transformations by the end of the first year (e.g., Tomasello, 1995), differences should also be observed when comparing the behavioral responses of infants at different ages.

Recent work by Delgado, Messinger, and Yale (2002) suggests that the loss of affective attunement during the still-face procedure may override the reason the adult stopped responding to the infant and posed a still face. In the study, 6-month-old infants were exposed to both a standard still-face procedure in which the mother broke contact to look directly at the infant (look-at condition) and a modified still face in which the mother broke contact to look above the infant (look-up condition). Although infants responded with less positive affect and more negative behaviors during the still-face situation compared with the preceding normal interaction, with only one exception they did not behave differentially as a function of the reason contact was broken. The only evidence that infants distinguished between these conditions was more neutral or positive vocalizing in the look-at condition when it preceded the look-up condition.

Although these results seem to suggest that 6-month-old infants are not sensitive to interpersonal intentions, such a conclusion is premature. It is necessary to test older infants to establish whether they respond the same way and to test infants in a condition in which there is a more evident reason contact is broken. In Delgado, Messinger, and Yale's

(2002) study, infants were not aware of the reason the social partner was looking away from them. The still-faced partner looked at a picture that was located behind and above the infants' head, and presumably infants did not gaze behind them to determine what the adult was looking at (see Symons, Hains, & Muir, 1998, for evidence that 5-month-olds do no follow vertical gaze shifts; see also Butterworth, 1991, for evidence that infants do not follow gaze behind them until 18 months of age). Second, it is possible that not all infants detected the vertical change in eye direction. Given that infants are sensitive to changes in head directionality (Caron, Caron, Roberts, & Brooks, 1997), varying head and eye direction to the side while manipulating the reason contact is broken would be a more powerful manipulation of the social partner's intention.

If, despite such manipulation, infants manifest a still-face response regardless of condition, it would suggest a possible primacy of interpersonal communication and social expectations in early human ontogeny. Accordingly, it is conceivable that from the start human infants are attuned to interpersonal intentions but that social expectations or the drive for communication overrides the motive or underlying mental state behind others' behavior. Delgado et al. (2002) alluded to this possibility: ''Due to the unfamiliar and potentially unpleasant nature of the still face condition, it is possible that during the still face episode infants are responding affectively to the lack of interaction by the parent rather than cognitively to the distinct social contexts created by changes in eye orientation'' (p. 6). If this hypothesis is valid, regardless of age and independent of the reason contact is broken, infants should respond similarly to the still-face procedure regardless of the situation or reason behind it.

The current studies examined this hypothesis and extended the prior work of Murray and Trevarthen (1985) and Delgado et al. (2002) in the following ways: In the first study, a cross-sectional cohort of infants was tested at key developmental transitions, with the same paradigm among 3-, 6-, and 9-month-old infants. Second, the cognitive dimension, that is, the reason contact was broken, was made more salient by manipulating both the social partner's head and eye directionality and providing a cue (reason) that could be heard and, with small shifts in eye gaze, seen by infants. In the second study, infants' social behavior was assessed while interacting with the mother to ensure that the effects of Study 1 were not merely due to the unfamiliar stranger. In addition, other extraneous variables, such as vocalizations and gaze direction, were controlled within participants. It was predicted that infants would not respond differentially based on the reason interpersonal contact was broken.

Study 1

Method

Participants

There were 120 full-term infants included in the final sample. Of these, 40 were 3-month-olds ($M = 103$ days, *range* = 80–119 days; 22 males and 18 females), 40 were 6-month-olds ($M = 188$ days, *range* = 169–212 days; 23 males and 17 females), and 40 were 9-month-olds ($M = 295$ days, *range* = 272–330 days; 22 males and 18 females). An additional 37 infants were tested but not included in the final sample because of experimental error ($n = 1$) or fussiness ($n = 36$). Infants were selected from a database of infants consisting of families who had expressed interest in volunteering for research in infant development. Approximately 90% were White and 10% were African American, all living in the South of United States. Infants were given a small gift for participating.

Materials

The procedure took place in a small child development laboratory room (approximately 8 feet × 12 feet). The room had white curtains placed around it, resulting in a homogenous background to prevent any visual distraction. Three- and 6-month-old infants were seated in a commercial infant seat. Nine-month-old infants were seated in a highchair with attached tray. A female experimenter was seated in front of the infants at eye level. The interaction was filmed and recorded via a camcorder (Panasonic AG-A186) that was placed at the infant's eye level behind the experimenter. The image was connected to a monitor placed behind the infant and out of view so that parents and a second experimenter could monitor and time the interaction.

Design and Procedure

The experiment consisted of two conditions. In Study 1, for both conditions, the session consisted of five 1-min episodes. Minutes 1 and 3 and 5 consisted of a normal interaction in which the experimenter engaged the infant in a face-to-face interaction, using infant-directed speech but without touching the infant. During Minutes 2 and 4, the experimenter stopped interacting with the infant and displayed a

neutral, silent, still face either directed at the infant or away. For infants in the wall condition, there was a still-face-toward episode, in which the experimenter maintained eye contact with the infant during the still face episode. For the still-face-away episode, the experimenter looked away from the infant toward a blank wall (turning her head and eyes approximately 45 degrees) during the still face. The side of the room where the experimenter directed her attention during the still-face-away episode as well as the order of still-face conditions (i.e., still face toward or still face away) were counterbalanced across infants at each age.

For infants in the person condition, at the start of the still-face period, the infant's mother (or caregiver) walked over to the area of the room where the experimenter and infant were interacting. A second experimenter signaled to the mother when to enter the room at the start of the still-face period. The mother stood approximately 45 degrees from the experimenter in front of and 3 feet to the left of the infant. To control for the amount of information that mothers provided (i.e., amount of vocalizations) and to control for their eye direction, mothers read a book aloud and were asked to remain visually focused on it throughout the still-face period. During the still-face episode, the experimenter either looked at the infant (still-face-toward condition) or looked away at the infant's mother (still-face-away condition). Following each still-face episode, the infant's mother walked behind a curtain placed behind and out of the infant's view. The experimenter resumed normal interaction following each still-face episode, and this signaled to the mother when to walk out of the experimental area. In summary, infants experienced a procedure similar to the wall condition except that in the still-face episode there was someone standing to the infant's side reading a book aloud.

Coding. Two coders viewed video records of the 5-min procedure for each minute of the procedure. While viewing video records of the infants' behavior in real time, two coders simultaneously recorded each dependent measure by pressing a button on a computer keyboard that activated a channel of a computerized event recorder.

Measures. Four behaviors were recorded. Based on previous research using a similar paradigm (Striano & Rochat, 1999; Toda & Fogel, 1993; Weinberg & Tronick, 1996), these behaviors were coded as a percentage of the total duration for each minute of the procedure. We were primarily interested in social-reengagement-action attempts; thus, only attempts to recapture the experimenter's attention that were clearly directed at the experimenter (i.e., accompanied by gazing) were coded.

Gazing: Any look to the experimenter's face.

Smiling: Cheeks rise and the sides of the mouth turn up while gazing.

Positive vocalizing: Any vocalizing accompanied by positive or neutral affect while gazing.

Reengagement actions: Any clapping, banging on the highchair, touching, or reaching toward the experimenter's face while gazing.

Reliability. For reliability, two independent coders analyzed 20% of infants for each age group. Cohen's kappas were calculated for each measure for each 1-s interval of testing. Cohen's kappa coefficient was .80 or above for all measures.

Results

Following the procedure of Hains and Muir (1996a), the groups were compared using a mixed-design analysis of variance (ANOVA) with age and condition as the independent factors. There were no interactions or main effects of gender; therefore, this variable was collapsed in subsequent analyses. It was predicted that infants would manifest a still-face response, with less gazing and positive affect in the still-face episodes compared with the normal interaction. Of particular interest was whether infants manifested different behavior as a function of the reason contact was broken, especially in the look-away conditions (i.e., look away wall or look away person). Alpha was set at .05, and thus all results reported as significant are $p < .05$ or better.

Gazing

Figure 1 illustrates infants' gazing as a function of age for both the wall and person conditions. Overall, infants at all ages gazed reliably more in the normal interaction conditions compared with the still-face conditions. There was a significant main effect of age, $F(2, 114) = 6.79$, such that 3-month-olds gazed reliably more than did 6- and 9-month-olds (Ms = 68.08, 59.87, and 55.76, respectively, but all groups manifested a similar still-face effect as illustrated in Figure 1). This is also shown with the ANOVA, which indicated a significant main effect of episode, $F(1, 114) = 189.31$, the linear, quadratic, cubic, and order 4 components were all significant. The still-face effect was present for both the wall and person conditions; however, there was significant Episode × Condition interaction, $F(1, 114) = 2.55$, with a significant linear component. As seen in Figure 1, infants gazed longer at the experimenter in the look-away, still-face, wall condition than in the

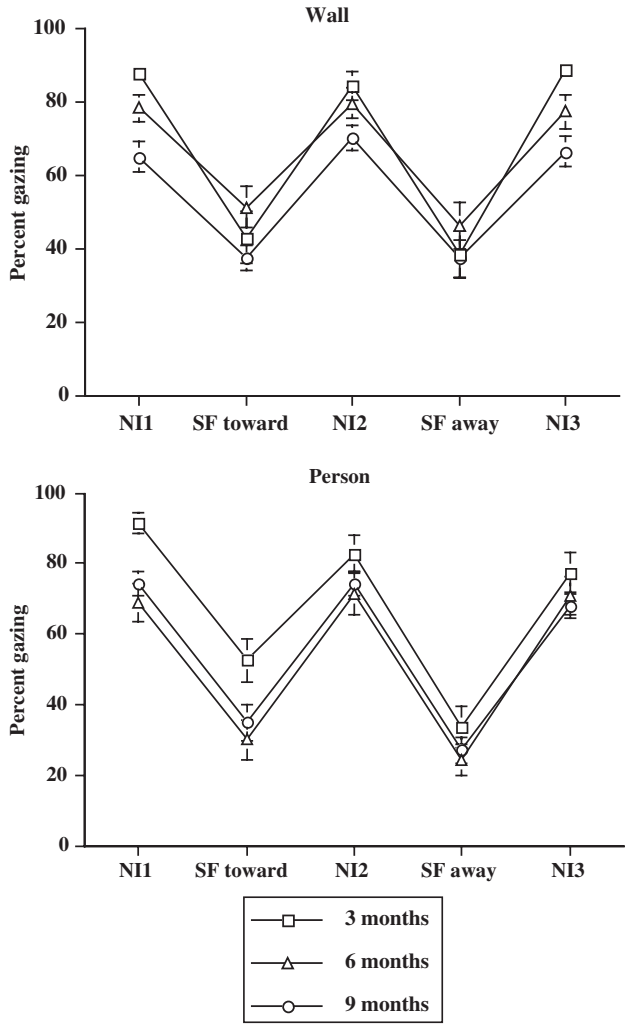

Figure 1. Percent of gazing and standard error as a function of age group and episode for the wall and person conditions for Study 1. NI = normal interaction; SF = still face.

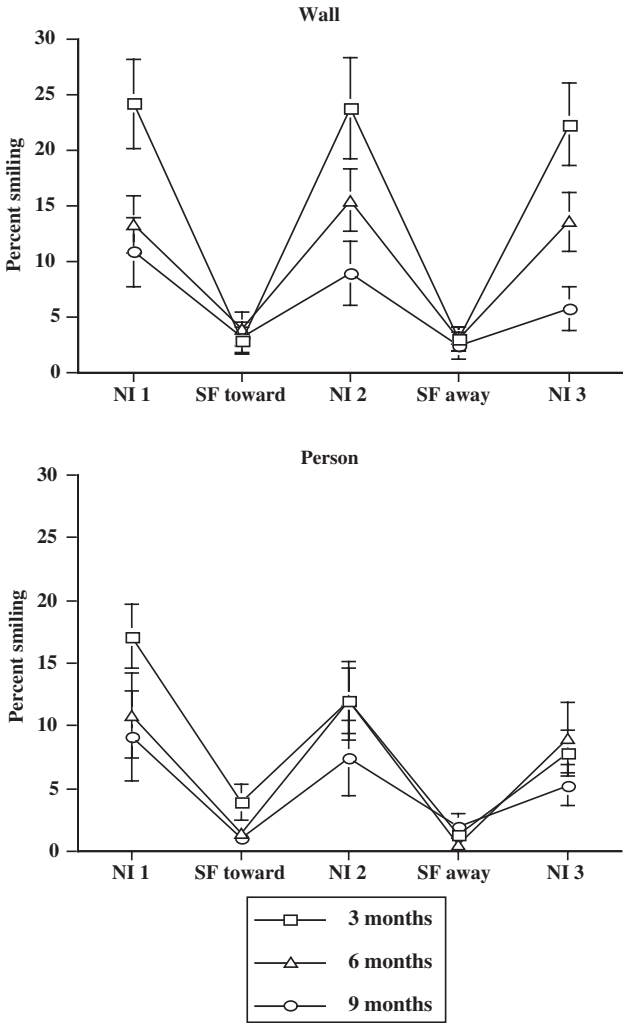

Figure 2. Percent of smiling and standard error as a function of age group and episode for the wall and person conditions for Study 1. NI = normal interaction; SF = still face.

person condition, $F(1, 114) = 8.25$. Performing an ANOVA for each condition revealed a significant episode effect: For the wall condition, the episode effect had a significant quadratic and order 4 component, and for the person condition, the episode effect had a significant linear, quadratic, cubic, and order 4 component. In general, the trends were similar between the conditions and for all ages, and there was no difference when comparing the still-face-away episodes for the wall or person condition.

Smiling

Figure 2 illustrates infants' smiling as a function of age for both the wall and person conditions. At all ages, infants' smiling response indicated a strong still-face effect. As shown in Figure 2, infants smiled reliably more in the normal interaction episodes than in the still-face episode. This was also shown by the significant main effect of episode, $F(1, 114) = 54.77$, which included a significant linear, quadratic, and order 4 component. There was also a significant main effect of age, $F(1, 114) = 6.60$, with 3-month-olds smiling reliably more than 6- and 9-month-olds (Ms = 11.81, 8.29, and 5.59, respectively), and an Episode × Age interaction, $F(2, 114) = 4.16$, such that there was a more pronounced still-face effect for smiling in the 3- and 6-month-olds.

There was a significant main effect of condition, $F(1, 114) = 6.68$, such that infants smiled more overall in the wall condition than in the person condition (Ms = 10.38 and 6.75, respectively). There was no difference for infants' smiling when comparing the still-face-away episode in the wall or person condition.

Positive Vocalizing

Figure 3 illustrates infants' positive vocalizing as a function of age for both the wall and person conditions. There was a significant main effect of episode, $F(4, 114) = 4.81$, with a significant linear component, showing that infants positively vocalized reliably less in the look-away conditions than in the normal interaction conditions. This effect was most pronounced for the 3-month-olds, as shown in Figure 3 and indicated by the significant Episode × Age × Condition interaction, $F(8, 114) = 2.02$. Performing an Episode × Age ANOVA for each age group indicated that only the 3-month-olds manifested a still-face effect with less positive vocalizing, $F(1, 38) = 8.02$, for the still-face-away condition. There was no significant difference for Normal Interactions 1 and 2 compared with the still-face-toward condition. There was significantly less positive vocalizing in the still-face-away condition than in all other conditions, and a significant recovery such that infants positively vocalized most in Normal Interactions 2 and 3. There was also no recovery following the still-face-toward episode. For the 6- and 9-month-olds, there were no significant effects for positive vocalizing. There was a significant main effect of age, $F(2, 114) = 14.94$, such that 3-month-olds positively vocalized reliably more than 6- and 9-month-olds (Ms = 4.83, 1.16, and 1.13, respectively). There was no difference for infants' positive vocalizing when comparing the still-face-away episode in the wall or person condition.

Reengagement Actions

Figure 4 illustrates infants' reengagement actions as a function of age for the wall and person conditions.

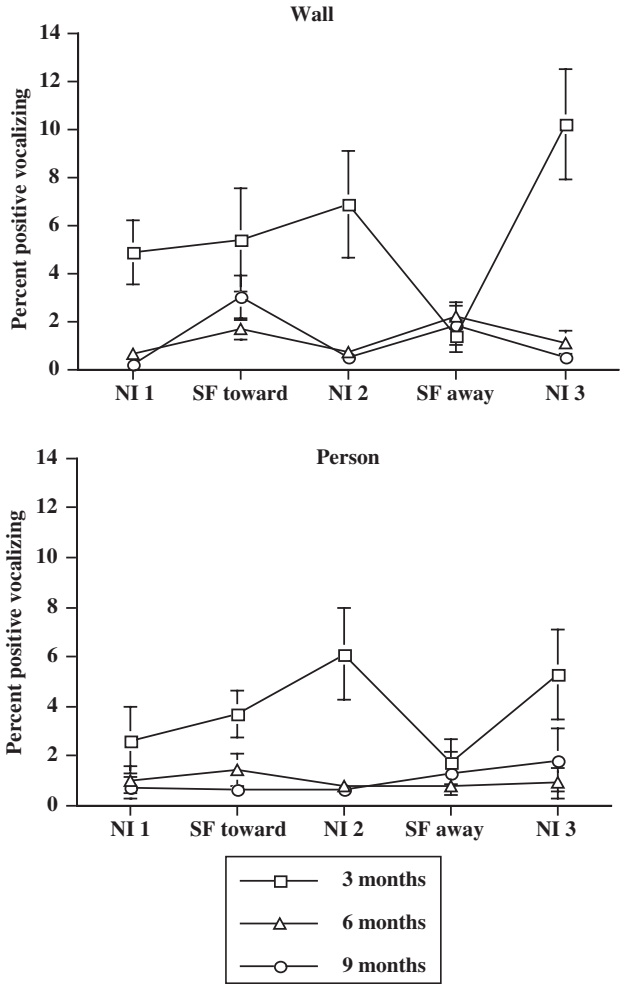

Figure 3. Percentage of positive vocalizing and standard error as a function of age group and episode for the wall and person conditions for Study 1. NI = normal interaction; SF = still face.

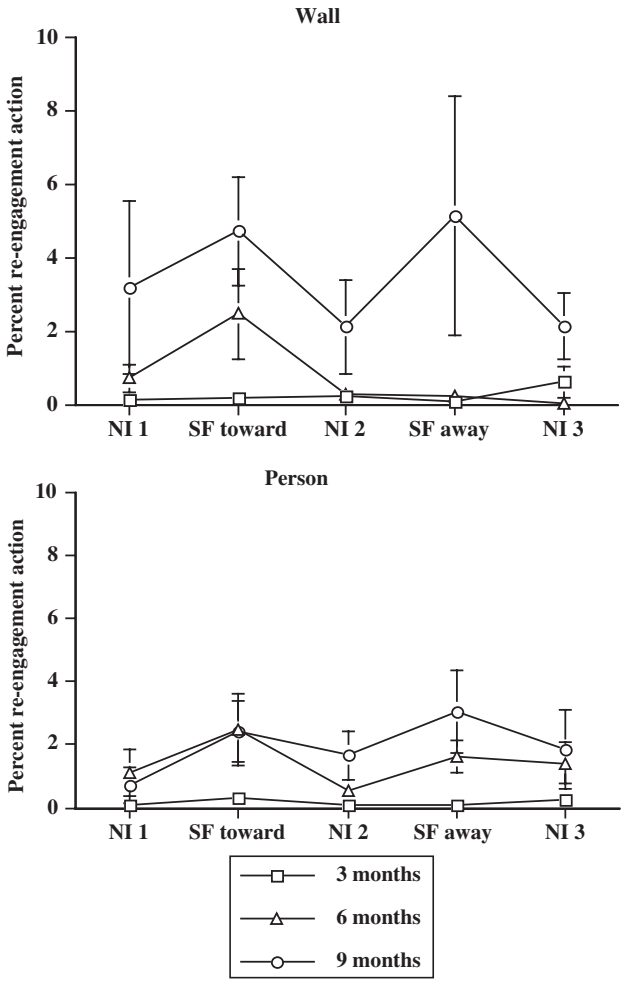

Figure 4. Percentage of reengagement actions and standard error as a function of age group and episode for the wall and person conditions for Study 1. NI = normal interaction; SF = still face.

For reengagement actions, there was a marginal significant main effect of episode, $F(1, 114) = 2.32$, $p = .055$, with a significant order 4 component. As seen in Figure 4, infants at all ages reengaged the experimenter more in the still-face periods than in the normal interaction periods. This effect was pronounced for the 9-month-olds. They performed more reengagement actions overall as indexed by a significant main effect of age, $F(1, 114) = 7.91$. Nine-month-olds used more reengaging actions toward the experimenter than did 3- and 6-month-olds (Ms = 2.69, .205, and 1.08, respectively), and they used marginally more reengagement actions in the still-face episode than in the normal interaction episode, $p = .073$.

Discussion

In Study 1, a modified still-face procedure was employed in which a female social partner broke contact with the infant for different reasons. The goal of the study was to establish whether infants in the first year manifest a differential still-face response as a function of the experimenter's intention, indexed by the reason contact was broken. It was predicted that infants would show a more pronounced still-face effect when the reason for breaking contact was clearly not evident. It was predicted that this effect would be especially pronounced in the look-away-at-wall condition compared with the look-away-at-person condition, given that in the former there was not a clear reason to look away.

The study extends the work of Murray and Trevarthen (1985) by providing experimental controls for head and eye directionality as well as vocalizations. The study also extends the finding of Delgado et al. (2002) by testing infants at younger and older ages and providing a salient reason for the break of dyadic contact. Overall, results showed that infants across all ages manifested a still-face effect. The research also confirms the use of the still-face procedure to assess social expectations and cognition over the first year. In relation to differences between infants' reaction as a function of the reason contact was broken, especially in the look-away conditions (look away at person or wall), there was scant evidence of any differentiation.

It is important to consider that, in addition to providing controls for talking and for eye and head directionality, Study 1 differed from Murray and Trevarthen's (1985) study in that a stranger rather than the mother was the social partner. It is possible that infants' developing expectations for mother and stranger differ (see also Bigelow & DeCoste, 2003; Hains & Muir, 1996a) and that infants are more tolerant of an intentional break in mother's contact because of prior experience that she usually reengages (Hains & Muir, 1996a).

Study 2 was thus designed to assess infants' response to the reason mothers break social contact to establish whether the same pattern emerges as in Study 1. The design is more comparable to that used by Murray and Trevarthen (1985). Study 2 controlled for eye directionality within participants while varying only the reason contract was broken. The design also had the advantage that there was no visual conflict presented during the still-face episodes as in Study 1. That is, rather than the adults' attention being captured by an object (i.e., the mother, as in Study 1), it was captured by a sound that could be heard and localized by the infant (see Muir & Clifton, 1985). It was inferred in this control that infants would understand that the sound was the reason the mother looked away from them. If infants understood there was a reason (i.e., sound) for the mother to look away and stop interaction, one possibility is that they would show a more pronounced still-face reaction (i.e., reduced gazing, smiling, positive vocalizing, and increased reengagement actions) in the no-sound episode given there was no reason for the break of contact. It was also possible, however, that infants understood something about the reason contact was broken but were similarly affected by the break of social contact in general and regardless of the underlying reason.

In this study, 3-, 6-, and 9-month-old infants interacted with their mothers for 5 min. In Minutes 1, 3, and 5 they engaged in a normal interaction, and in Minutes 2 and 4 mothers broke dyadic contact with the infant to look away either for no reason (no sound) or because they heard someone reading. In both instances, contact was broken (i.e., social dimension) but for different reasons (i.e., cognitive reason). Based on the findings from Study 1 and on the findings of Delgado et al. (2002), the working hypothesis was that infants would manifest a response to the still face but that this response would not differ as a function of the reason contact was broken (i.e., sound or no sound).

Study 2

Method

Participants

Thirty-two healthy, full-term infants were included in the final sample. Of these, 10 were 3-month-olds ($M = 98$ days, *range* = 90–113 days; 2

males and 8 females), 11 were 6-month-olds ($M = 187$ days, *range* = 175–208 days; 5 males and 6 females), and 11 were 9-month-olds ($M = 284$ days, *range* = 264–303 days; 7 males and 4 females). An additional 5 infants were tested but not included in the final sample because of fussiness. Infants were selected from a database of infants consisting of families who had expressed interest in volunteering for research in infant development. All infants were White and living in the east of Germany. Infants were given a small gift for participating.

Materials

The procedure took place in a small child development laboratory room (approximately 8 feet × 16 feet). The room had white curtains placed around it, resulting in a homogenous background to prevent any visual distraction. Three- and 6-month-olds were seated in a commercial infant seat. Nine-month-olds were seated in a highchair without an attached tray. Note that unlike in Study 1, many infants did not tolerate the highchair with the tray. This was probably due to a cultural bias. Many mothers informally report not seating the infants in chairs or highchairs because of concerns of infants' developing posture. The mother was seated in front of the infants at eye level. Two pieces of foamboard (approximately 4 feet × 3 feet) were positioned diagonally to form a barrier on each side of the infant, such that the infant could not see the experimenter. The interaction was filmed and recorded via a digital camcorder that was placed at the infants' eye level behind the mother. The image was connected to a monitor placed behind the infant and out of view so that the experimenter could monitor and time the interaction.

Design and Procedure

The experiment consisted of five 1-min episodes. Minutes 1, 3, and 5 consisted of a normal interaction in which the mother engaged the infant in face-to-face interaction, using infant-directed speech but without touching the infant. During Minutes 2 and 4, the mother stopped interacting with the infant and displayed a neutral, silent, still face, while looking away from the infant. The experimenter signaled to the mother when to start and stop each condition by waving her arm. In the look-away condition (Minutes 2 and 4), mothers turned their head and eyes away from the infant, approximately 45 degrees. In the sound condition, they looked past the barrier to the sound source behind the barrier, and in the no-sound condition, they turned their head approximately 45 degrees to the side and looked at an unmarked spot at the top of the barrier.

In the sound condition, the experimenter started reading a book aloud for 1 min, and in the no-sound condition there was no sound. In all cases, the experimenter was in the room and out of the infant's view. The side to which the mothers looked was counterbalanced across infants. The experimenter always sat on the side of the room that the mother turned toward, such that mothers looked to the general direction from which the sound was emanating.

Coding and Reliability

The same coding system as in Study 1 was used except that banging on the table was not included as part of reengagement actions. Waving of the arms or banging other parts of the chair with effort were included as reengagement actions when accompanied by gazing. The reliability for all measures was conducted by a researcher blind to the hypotheses of the study, and for 20% of the sample mothers sat in front of their infant at eye level. Kappa coefficients for all measures were above .77.

Results

There were no significant effects of side of the room that mothers looked toward, order of episodes, or gender. Therefore, these variables were collapsed in subsequent analyses. A five-episode (Normal Interaction 1, sound, Normal Interaction 2, no sound, Normal Interaction 3) mixed-design ANOVA was performed with age group (3, 6, and 9 months) as the independent factor. Alpha was set at .05; thus, all results reported as significant are $p < .05$ or better.

Gazing

Figure 5A shows gazing response as a function of episode. Regardless of age, infants gazed reliably more in the normal interaction episodes than in the still-face episodes. There was a significant main effect of episode, $F(4, 104) = 7.99$, with an order 4 component. There was reliably less gazing in the no-sound condition than in the normal interaction condition, and less gazing in the sound condition than in Normal Interaction 3. There were no significant differences between the still-face sound and no-sound episodes.

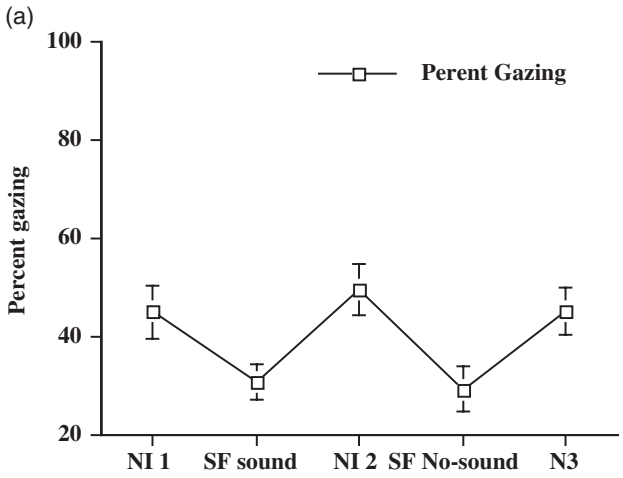

Figure 5A. Percentage of gazing and standard error as a function of episode for Study 2. NI = normal interaction; SF = still face.

Smiling

Figure 5B shows smiling response as a function of episode. There was a significant episode main effect, $F(4, 104) = 8.93$, with an order 4 component. Pairwise contrasts revealed that, regardless of age, infants smiled reliably less in the still face conditions (sound and no sound) than in the normal interaction conditions. There were no significant differences between the still-face sound and no-sound episodes.

Positive Vocalizing

Figure 5C shows positive vocalizing response as a function of episode. There was a significant main effect of episode, $F(1, 104) = 2.41$, with a marginal cubic trend, $p = .075$. Pairwise contrasts revealed reliably that infants engaged in more positive vocalizing in Normal Interaction 3 than in the sound condition. There were no significant differences between the still-face sound and no-sound episodes.

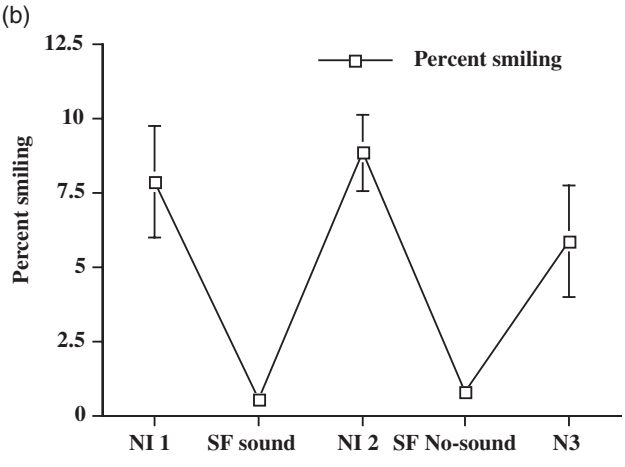

Figure 5B. Percentage of smiling and standard error as a function of episode for Study 2. NI = normal interaction; SF = still face.

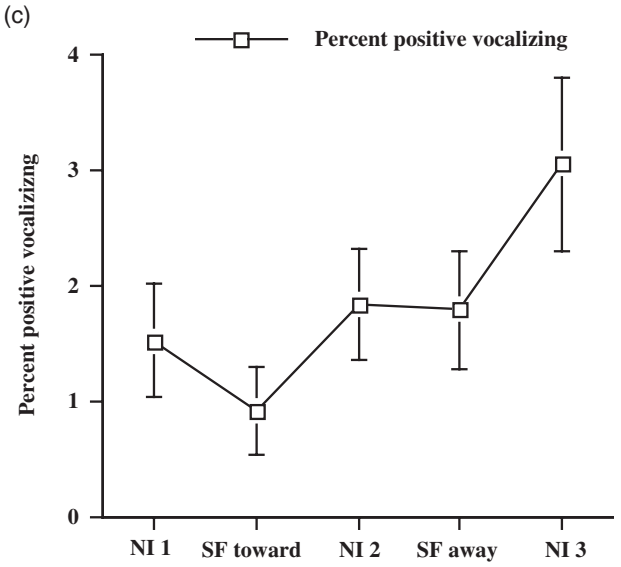

Figure 5C. Percentage of positive vocalizing and standard error as a function of episode for Study 2. NI = normal interaction; SF = still face.

Reengagement Actions

There were no significant main effects or interactions ($M = 2.59$ for Normal Interaction 1, $M = 2.077$ for sound, $M = 2.65$ for Normal Interaction 2, $M = 6.11$ for no sound, and $M = 2.04$ for Normal Interaction 3). This may reflect a difference between mother and stranger as social partner (see also Bigelow & DeCoste, 2003; Hains & Muir, 1996a).

Discussion

The question of whether infants are influenced by mothers' intentions in breaking dyadic contact was assessed. Infants across all ages manifested a reliable still-face response when their mother stopped interacting with them to look away. The results replicate those of Study 1, in which an unfamiliar stranger interacted with infants. It is interesting to note, however, that age effects in Study 2 were not as pronounced as in Study 1. In addition, infants tended to gaze and smile less at their mother (Study 1) than at the stranger (Study 2). In future work it would be useful to assess directly infants' response to mothers versus strangers in a similar paradigm. In all, the underlying reason the mother looked away,

whether because she heard something in the room or for no apparent reason, did not influence infants' behavior. There were no differences between infants' behavior in the sound and no-sound episodes. Result suggests that across the ages tested, infants are highly motivated to interact with others, and they respond to being ignored regardless of the underlying reason for breaking contact.

General Discussion

In two studies, 3-, 6-, and 9-month-old infants' still face reactions were assessed as they interacted with a stranger or their mother. Using a modified still-face procedure, the reason contact was broken was manipulated. Overall, the results show that by 3 months of age, infants are sensitive to others' attentional states and respond with less positive affect when contact is broken, regardless of the reason. These findings point to what may be a unique and deep-rooted inclination in humans. Unlike any other species, humans are motivated to share attention with others. They engage in cooperative activities such as language (Clark, 1996; Tomasello, 2000) and other symbolic activities that may have evolved out of a necessity and inclination to share with and communicate with others (see Hobson, 2002).

Although some theorists suggest that it is not until the end of the first year that infants tune into others' attentional states and understand others as intentional (e.g., Carpenter et al., 1998; Tomasello, 2000), the current findings show that an inclination to communicate and to understand if attention is directed at or away from the self starts well before the end of the first year. Already by 3 months of age infants were perturbed when someone broke dyadic contact with them, regardless of the reason or whether this interaction was with a stranger or with a familiar caregiver. The fact that this effect was consistent across ages and across social partners points to the strong and general inclination of the young infant to engage in interpersonal communication.

The study did not replicate the original phenomenon reported by Murray and Trevarthen (1985), in which mothers stopped interacting with their 6- to 12-week-old infants to pose a blank face or to talk to someone who had entered the room. One reason for this difference may be that infants were not upset in Murray and Trevarthen's interruption condition because their mother continued to talk, albeit to another person. However, a variety of studies using double videocommunication suggest that a noncontingent voice is not enough to maintain interpersonal communication between mothers and infants (i.e., Gusella, Muir, & Tronick, 1988; Nadel, Carchon, Kervella, Marcelli, & Reserbat-Plantey, 1999).

In part, the findings are in accordance with Murray and Trevarthen's (1985) theoretical position. The authors wrote that "infants of 6–12 weeks have the capacity to detect features of the structure of mother's behavior (e.g., direction of her gaze, her facial expression, rhythm of movement and voice quality). In addition, they appear to respond to the constellation of these in terms of the coordinated structures of interpersonal and emotional value, and finally they regulate their own expressions in appropriate, complementary response patterns that can be perceived by the mother as particular emotions" (p. 192).

Along these lines, the current findings suggest that infants as young as 3 months of age are highly attuned to others. In addition, they are sensitive to the direction of others' gaze and the presence or absence of interpersonal contact. The question therefore remains why, if they are endowed with or develop such capacities, infants did not manifest differential responsiveness as a function of the reason interpersonal contact was broken. One possibility is that the mean age of infants in the current study was higher than those tested by Murray and Trevarthen (3-month-olds vs. 6- to 12-week-olds; 1985). However, a second and more plausible explanation is that there was not a good enough reason contact was broken and that the situation led infants to respond to the constellation of ambiguous behaviors in which the social partner engaged. Unlike in Murray and Trevarthen's study, the social partner was still for an entire minute, simply sitting and staring at either the infant, a wall, or a person who came into the room. It may have been difficult for infants to make sense of the social partner's behavior even if it were directed at something. Although the look-away-at-person condition (Study 1) and look-away-at-sound-source condition (Study 2) were intended to set up a reason for the interpersonal break of contact, it is likely that infants were sensitive to this unnatural break and responded appropriately.

I am currently investigating how infants respond when there is a more naturalistic break in contact that can potentially be shared or jointly attended toward. In the current studies, communication (i.e., joint attention) was not maintained given that the social partner never made any attempt to look back to the infant or to share something about the reason contact was broken (see also Hobson, 2002). Rather, the social partner looked away from the infant, in a sense ignoring him or her.

What the current studies demonstrate is a deep-rooted drive to communicate with others and not be ignored. In fact, this inclination did not undergo much change over the first year and did not depend on the familiarity of the interactive partner. It suggests that human infants' drive to communicate and to have others attend to them starts well before the end of the first year with the emergence of systematic joint attention (i.e., Carpenter et al., 1998; Tomasello, 1995). The key is to assess whether such inclinations reflect a human adaptation that affords unique aspects of culture such as language and theory of mind.

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