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Intention or expression? Four-month-olds' reactions to a sudden still-face

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Abstract

We addressed whether 4-month-old infants are primarily influenced by the expression or intention underlying a sudden still-face response by an adult social partner. Sixteen dyads of 4-month-old infants interacted with an adult who posed a still-face directed at one of the two infants. Infants' gazing and smiling responses confirm that they are primarily influenced by the emotional and contingency loss rather than the intention underlying the adult's still-face.

Keywords: Still-face; Intention; Emotion; Contingency; Cognition; Development

1. What's the intention? Four-month-olds' reactions to a sudden still-face

Eye contact is a fundamental part of adult social communication, providing information about others' social motives and cues about when to begin and end social interactions (see Argyle & Cook, 1976). A number of studies have shown that neural processing of social information by adults is influenced by whether this information is directed at the self or elsewhere (e.g., see Wicker, Perrett, Baron-Cohen, & Decety, 2003). The eyes are also a significant part of social communication in early ontogeny. From birth, human infants look longer at a face with direct compared to averted eye gaze (Farroni, Massaccesi, Pividori, & Johnson, 2004; see also, Vecera & Johnson, 1995), and at a face with eyes open compared to a face with eyes closed (Batki, Baron-Cohen, Wheelwright, Connellan, & Ahluwalia, 2000).

By 2–3 months of age, eye contact also plays an integral role in infant–adult interaction (Ellsworth, Muir, & Hains, 1993; Hains & Muir, 1996b; Symons, Hains, & Muir, 1998). Around this time, human infants are sensitive to interpersonal social contingencies. For instance, by 2–3 months of age infants manifest more social responsiveness toward an adult who interacts with them in a live compared to in a replayed interaction (Murray & Trevarthen, 1985; Nadel, Carchon, Kervella, Marcelli, & Reserbat-Plantey, 1999; Striano, Henning, & Stahl, 2005) or in a live compared to a 1 s delayed interaction (Striano, Henning, & Stahl, in press). A wide body of literature converges

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to show that young human infants have expectations about the nature of appropriate social responses from other people.

The still-face paradigm originally developed by Tronick, Als, Adamson, Wise, and Brazleton (1978) has been one of the most frequently utilized and robust paradigms to address questions related to the development of infants' understanding of others' interactions with them (Adamson & Frick, 2003). The procedure begins with an adult engaging the infant in a normal face-to-face interaction, followed by a period in which the adult suddenly freezes, becomes unresponsive, and poses a stationary expression (still-face). The still-face episode is generally followed by an additional period of normal face-to-face interaction. Infants as young as two months of age manifest a robust still-face response, with significantly reduced durations of gazing and smiling toward the adult during the still-face episode, and more self-comforting behavior when compared with normal interaction periods (e.g., Lamb, Morrison, & Malkin, 1987; Murray & Trevarthen, 1985; Tronick et al., 1978). The general interpretation of these findings is that young infants have expectations about the way that face-to-face interactions should proceed, and about the nature of appropriate interactive responses from social partners (e.g., Ellsworth et al., 1993; Muir & Hains, 1993; Nadel et al., 2000; Rochat & Striano, 1999).

It is widely accepted that young human infants are sensitive to interruptions of social interactions over the first year, but much less is understood regarding young infants' interpretation of the still-face (see also Striano, 2001). That is, are young infants sensitive to the underlying motive of the still-face that others direct toward them, or are they primarily influenced by a loss of interpersonal contact regardless of the underlying reason? The majority of studies that have investigated such questions have been limited in some ways.

For instance, Striano (2004) tested whether 3-, 6-, and 9-month-old infants are sensitive to the underlying motive, or reason, that a still-face was directed at them by an adult stranger. Infants across all ages manifested a robust still-face effect, independent of the reason that the adult stopped interacting with them-whether the adult broke contact to stare at the infant, a blank wall, or an adult who entered the room. However, it was unclear in this study whether the reason that contact was interrupted was sufficient for infants to detect (see also Caron, Butler, & Brooks, 2002; Hains & Muir, 1996a). Others have noted that nature of the experimental procedure may have important effects on the behaviors exhibited by infant subjects (e.g., Hains & Muir, 1996b).

In this study, we extended prior research on the still-face by introducing a design in which the adult social partner directed a still-face toward one of two infants. Fivaz-Depeursinge et al. (1994), Fivaz-Depeursinge, Frascarolo, and Corboz-Warnery (1996), Fivaz-Depeursinge, Favez, Lavanchy, de Noni, and Frascarolo (2005) have documented that infants are sensitive to triadic interactions, but no studies have followed up on these reports. By having an adult interact with two infants of the same age, we attempted to create a triadic social exchange in which we could tease apart whether infants are sensitive to the intention of the still-face.

We used the working hypothesis that if infants are primarily influenced by the intention underlying the adult's still-face, defined here as the reason contact was broken, they would manifest a greater reduction in smiling and gazing toward the adult when the still-face was directed at them compared to when the still-face was directed at the other infant. That is, if the primary reason underlying the decreased gazing and smiling typical of a still-face response is an infants' recognition that the adult has no clear *reason* for interrupting a dyadic interaction, we expected that the infant would manifest a more robust response during a still-face directed towards the infant rather than away. If, however, infants are primarily sensitive to expression (i.e., eye contact and smiling) directed at them, they should manifest a more robust response to the still-face when it is directed at the other infant, given that fewer social cues are available in this situation. We also expected that infants would gaze and smile significantly more toward the Experimenter during periods of normal interaction than during either of the still-face periods, a result that would be consistent with previous studies of infants during the first year of life (e.g., Cohn & Tronick, 1989; Muir & Hains, 1993; Rochat, Striano, & Blatt, 1999; Tronick et al., 1978). Our hypotheses are summarized below.

Summary of predictions:

1. We expected that all infants would exhibit an overall still-face response. Specifically, we expected that infants would manifest decreases in gazing and smiling during all still-face episodes relative to the normal dyadic interactions. Predictions 2 and 3 were designed to aid in the interpretation of this still-face response.
2. If infants are sensitive primarily to the communicative *intention* of the adult (i.e., infants discern the reason for a break in contact (looking at another infant) versus a sudden lack of response without apparent reason), then infants

should exhibit decreased smiling and gazing when the still-face is directed towards them relative to when a still-face is directed toward another infant.
3. Alternatively, if infants primarily use social cues such as gazing and smiling to determine the beginning and end of dyadic interactions, infants should show decreased smiling and gazing when the still-face is directed toward another infant relative to when the still-face is directed toward the self.

2. Method

2.1. Participants

The final sample included thirty-two 4-month-old infants, counterbalanced for sex (16 males and 16 females: mean age = 3.53 months; range = 3 months, 5 days–4 months, 15 days; S.D. = 0.457). An additional 16 infants were tested but were not included in the final sample; of these, 2 infants were excluded due to the lack of a partner, 8 due to fussiness, and 6 were excluded because of technical problems with recording equipment. All participants were reported to be healthy and had been carried to term (at least 37 weeks gestation). The subjects were recruited by telephone from a database consisting of a list of infants whose caregivers had previously expressed interest in having their infants participate in developmental studies. All infants were Caucasian, from a small city in the east of Germany, and from middle-class families. Infants were given a small toy for participation.

2.2. Set-up and procedure

Testing took place in a carpeted room within an area surrounded by white curtains in order to eliminate possible distractions. All sessions were filmed using four digital cameras. One camera was focused on a close-up of the face of each infant, one on the face of the Experimenter, and the last captured an overview of the entire experimental set-up.

Two infants of the same sex participated in each experiment, and both remained present during the entire procedure. The two infants faced the same direction, each in a commercial infant seat, with their seats placed a short distance from each other, and angled slightly to face the Experimenter. An Experimenter sat in a chair facing the infants, equidistant from each and centered between them. Mothers sat behind the infants, out of the infants' visual fields, and watched the experimental procedures over a video monitor.

The Experimenter (E) began the procedure by engaging in a normal interaction with one of the infants (Infant 1, I1) for a period of 30 s. During this time, E talked in a positive tone of voice to the infant, maintaining eye contact during the entire period. A second Experimenter (E2) cued E1 at the end of the 30 s, and at this cue, E ceased interaction, assuming a stationary positive, yet unresponsive, expression while gazing toward the infant (*Still-Face Toward* condition) with whom she had been interacting (I1). At the end of a 30 s period, E immediately resumed a normal interaction with I1, once again talking pleasantly and maintaining eye contact. This episode was followed by a second still-face, identical to the first, except that it was directed by E toward Infant 2 (i.e., directed away from the infant to whom E had been directing social interaction, and directed toward I2) for 30 s (*Still-Face Away* condition). During the first three series of interactions, the second infant had been able to observe the interactions between the Experimenter and Infant 1, but E did not look at, talk to, or engage in social interaction with Infant 2.

Following the *Still-Face Away* condition, E spent 30 s talking pleasantly to and maintaining eye contact with Infant 2. E then interrupted normal interaction to engage in a still-face episode directed toward I2. Following this 30 s period, E again talked with I2 pleasantly for 30 s while maintaining eye contact, and then directed a still-face away from I2, and toward Infant 1, for 30 s. A 30 s period of normal interaction with I2 concluded the experiment. In short, each infant received the same social interactions from the Experimenter over the experimental period.

In summary, the experiment consisted of two very similar periods—one in which the Experimenter primarily interacted with Infant 1, and one in which she prmarily interacted with Infant 2. During each part of the experiment, each infant was received both a Still-Face Toward and a Still-Face Away episode; what differed across periods was the nature of the normal adult interaction with the infant, with the Experimenter interacting with only one infant in normal face-to-face interactions (*Interaction Period*, see Table 1), while the other infant had the opportunity to observe these interactions, but the adult did not interact directly with him/her (*Non-Interaction Period*, see Table 1). The *Still-Face Away* condition for one infant was a *Still-Face Toward* condition for the other (see Table 1), and each received the same

Table 1
Experimental procedure

1.	Talk/Normal Interaction Toward	Talk/Normal Interaction Away	Interaction Period for Infant 1/
2.	Happy SF Toward	Happy SF Away	
3.	Talk/Normal Interaction Toward	Talk/Normal Interaction Away	Non-Interaction Period for Infant 2
4.	Happy SF Away	Happy SF Toward	
5.	Talk/Normal Interaction Away	Talk/Normal Interaction	Interaction Period for Infant 2/
6.	Happy SF Away	Happy SF Toward	
7.	Talk/Normal Interaction Away	Talk/Normal Interaction	Non-Interaction Period for Infant 1
8.	Happy SF Toward	Happy SF Away	

number of *Normal Interaction Toward*, *Normal Interaction Away*, *Still-Face Toward* and *Still-Face Away* episodes. The duration of one entire experiment was 240 s.

2.3. Coding

Interaction episodes were scored by a trained coder blind to the experimental hypotheses. For each 30-s interaction period, the duration of infant gazing and smiling while gazing toward the Experimenter was recorded for both Infant 1 and Infant 2. *Gazing* was defined as any look toward the Experimenter's face, and *smiling* was scored when the infant exhibited raised cheeks with at least one corner of his/her mouthed turned up, regardless of whether his/her mouth was open or closed. For each infant, gazing and smiling while gazing were computed as a percentage of total possible time available during the episode (e.g., gazing during the *Normal Interaction* period was computed as: # seconds infant spent gazing during *Normal Interaction*/Total # seconds in the *Normal Interaction* period).

To assess intercoder reliability, a second naïve coder scored a random 25% of the interaction sessions. The agreement between the two coders was Cohen's kappa 0.941 for gazing and 0.917 for smiling.

3. Results

3.1. Effects of possible confounding factors

Preliminary analyses using repeated measures ANOVAs revealed no significant effects of sex, order, or side (looking direction of the experimenter). In addition, preliminary results indicated no significant differences with respect to smiling or gazing durations between the two dyadic *Normal Interaction* periods; therefore, these periods were collapsed for all subsequent analyses comparing normal interactions with the still-face episodes during the *Interaction* period (see Table 1).

3.2. Infant behavior across interaction and non-interaction periods

3.2.1. Gazing

Wilcoxon Paired Samples tests were used to examine differences in infant gazing time across periods (*Interaction* versus *Non-Interaction*) during the *Still-Face Toward* and *Still-Face Away* episodes. No significant differences were observed in terms of the amount of gazing infants exhibited between *SF Toward 1/SF Toward* 2, and *SF Away* 1/*Still Face Away* 2 (two-tailed, $p > 0.10$ for both). Infants did differ significantly in terms of gazing time across the *Normal Toward* (*Interaction Period*) and *Normal Away* (*Non-Interaction Period*) episodes (Wilcoxon Signed Ranks, $n = 32$, $z = -2.900$, $p = 0.004$); infants smiled more during the *Normal Interaction Toward* episodes (see Fig. 1a).

3.2.2. Smiling

Wilcoxon Paired Samples tests revealed no significant differences in infant smiling between *SF Toward* 1/*SF Toward* 2, and *SF Away* 1/*Still Face Away* 2; in other words, infants did not differ in the percentage of time they smiled across the *Interaction* and *Non-Interaction* periods with respect to the same still-face stimuli. Smiling time across the *Normal Toward* (*Interaction Period*) and *Normal Away* (Non-*Interaction Period*) episodes differed significantly

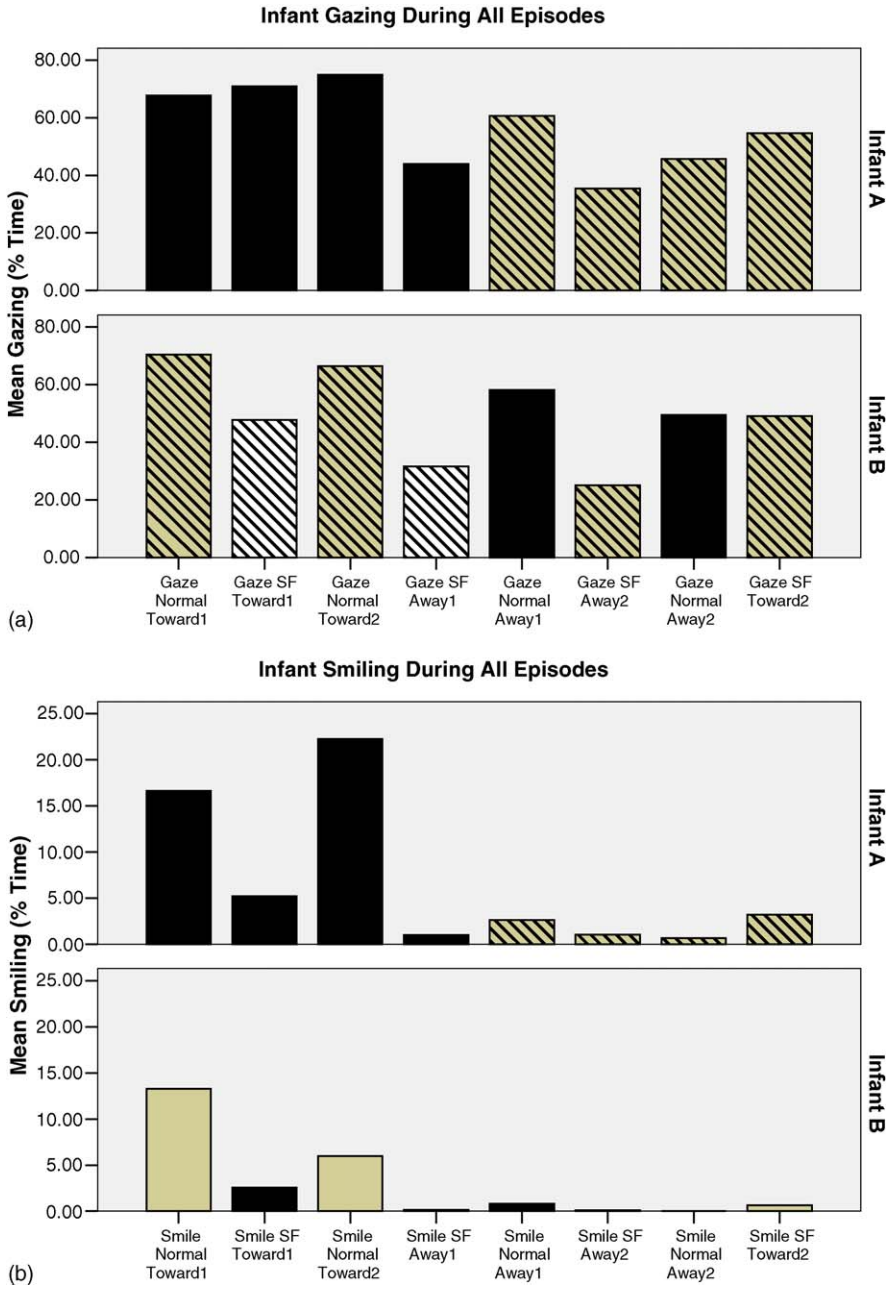

Fig. 1. (a) Percentage of time infants spent gazing to the Experimenter during each episode in the experiment. The graph labeled "Infant A" represents the gazing time for infants that engaged in normal face-to-face interactions with the Experimenter first during the experimental session. The "Infant B" graph contains data for the infants that the Experimenter engaged second. Solid black bars represent episodes that took place during the *Interaction* period, while striped bars represent those that took place during *the Non-Interaction* period. (b) Percentage of time infants spent smiling to the Experimenter during each episode in the experiment. The graph labeled "Infant A" represents the gazing time for infants that engaged in normal face-to-face interactions with the Experimenter first during the experimental session. The "Infant B" graph contains data for the infants that the Experimenter engaged second. Solid black bars represent episodes that took place during the *Interaction* period, while striped bars represent those that took place during *the Non-Interaction* period.

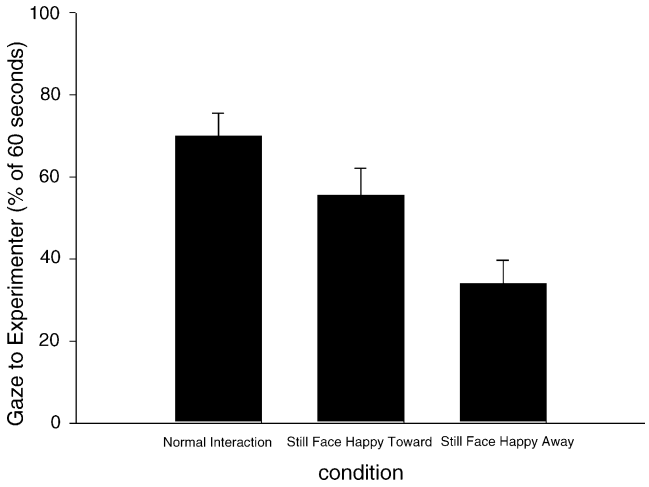

Fig. 2. Proportion of total time infants spent gazing at the Experimenter during the Normal Interaction, Still-Face Toward, and Still-Face Away conditions. Each condition lasted a total of 60 s.

(Wilcoxon Paired Samples, $n = 32$, $z = -3.969$, $p = 0.000$), with infants smiling more during the *Normal Interaction Toward* episodes (see Fig. 1b.)

3.3. Infant behavior across normal interaction and still-face episodes

Our next analyses focused on only the *Interaction Period* (the four episode period consisting of two *Normal* interactions, one *Still-Face Toward*, and one *Still-Face Away* episode). The purpose of excluding the *Non-Interaction* period during this series of analyses was to assess the reactions of infants to a still-face episode when the still-face interrupted a normal, contingent social interaction with an adult.

3.3.1. Gazing

A repeated measures analysis of variance (ANOVA) with episode entered as the within-subject factor (*Normal Interaction*, *Still-Face Toward*, *Still-Face Away*) revealed a significant effect of episode type ($F(2,62) = 29.135$, $p < 0.001$) for gazing duration. LSD pairwise comparisons revealed that infants gazed at the experimenter significantly longer during the *Normal Interaction* condition than during either the *Still-Face Toward* condition ($p < 0.02$) or the *Still-Face Away* condition ($p < 0.001$), and that infants gazed longer toward the Experimenter in the *Still-Face Toward* condition than in the and *Still-Face Away* condition ($p < 0.001$; see Fig. 1).

3.3.2. Smiling

A repeated measures ANOVA with the three episode levels entered for factor (*Normal Interaction*, *Still-Face Toward*, *Still-Face Away*) revealed a significant effect of episode type ($F(2,62) = 16.701$, $p < 0.001$) for smiling while gazing at the Experimenter. LSD pairwise comparisons indicated that infants smiled more while gazing at the Experimenter during the *Normal Interaction* periods than during the *Still-Face Toward* ($p < 0.002$) or *Still-Face Away* ($p < 0.001$). The differences between the *Still-Face Toward* and *Still-Face Away* conditions approached significance ($p < 0.057$); see Fig. 2), with infants smiling toward the Experimenter more during the *Still-Face Toward* period.

4. Discussion

In this study, we assessed whether 4-month-old infants are primarily influenced by the expression (eye contact and smiling) directed at them during a still-face or if they are primarily influenced by the intention underlying the still-face response. If infants are sensitive to the intention of the adult's still-face, we expected that they would respond to the still-face with less gazing and smiling when it was directed at them (i.e., intended for the self) compared to when it was directed at another infant of the same age (intended for the other) (Fig. 3).

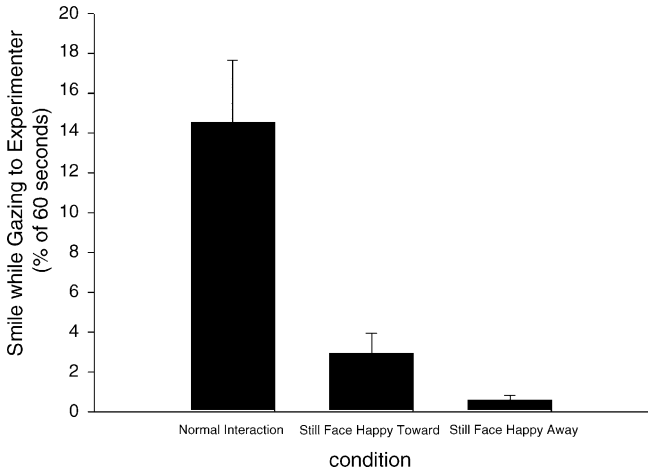

Fig. 3. Proportion of total gazing time that infants spent smiling at the Experimenter during the Normal Interaction, Still-Face Toward, and Still-Face Away conditions. Each condition lasted a total of 60 s.

Overall, we found evidence for a robust still-face response in 4-month-old infants. Specifically, infants exhibited significantly reduced durations of gazing and smiling directed at the adult Experimenter during both the *Still-Face Toward* and *Still-Face Away* conditions relative to the *Normal Interactions*. The finding that infants manifested a still-face response is consistent with previous studies in which the still-face paradigm has been employed with infants of the same age (Rochat et al., 1999).

In addition, the infants in this study also gazed at the Experimenter significantly less in the *Still-Face Away* condition compared to the *Still-Face Toward* condition, despite the fact that the Experimenter's gaze away was directed to another infant. A similar patter was found for smiling. It is important to note that by 4 months of age, infants follow the direction of another's gaze, and that the triadic interaction paradigm was well adapted to test infants of this age range (see also, Fivaz-Depeursinge et al., 2005). We used the working hypothesis that infants would exhibit a less robust still-face response if the reason for the adult's break in contact was clear. In fact, the opposite was true; when an adult broke contact to look towards another infant of the same age (*Still-Face Away* episode), infants actually exhibited a *more* robust still-face response, gazing and smiling significantly less to the Experimenter compared to the *Still-Face Toward* episode.

These findings suggest that 4-month-old infants likely use mutual gaze to determine the onset of social interactions, and that they use this information to modify their own behavior within triadic episodes. Our results are consistent with Stern's hypothesis (1974) that the initiation and termination of eye contact by adults may provide valuable cues to infants about the timing of social interactions. In particular, Stern suggested that eye contact helps infants to know when social interactions are beginning (with initiation of eye contact) and when they end, which is signaled by averted gaze. In the present study, the results suggest that eye contact functioned in this way, with infants gazing and smiling more to the Experimenter when eye contact and smiling was maintained (*Still-Face Toward*) compared to the condition in which the adult looked away from the infant (*Still-Face Away*).

Evidence from other areas of developmental psychology has shown that eye contact is an important cognitive signal. For example, Farroni, Csibra, Simion, and Johnson (2002) provided evidence of enhanced neural processing of mutual gaze in 4-month-olds using event-related potentials (ERPs). In their study, they focused on N170, an ERP component which is known to be sensitive to faces in adults. Twelve of the fifteen 4-month-olds used in their study showed a more negative "Infant N170" to an image of an adult with direct versus averted gaze.

It is important to note, however, given our broader findings that infants looked to and smiled toward the Experimenter significantly less during both still-face episodes relative to the *Normal Interaction* condition, it is clear that mutual gaze is only one of several factors involved in the interpretation of social information in adult-infant interactions. Previous research has shown that factors such as emotional expression, vocal cues, and movement may also provide important information to infants for interpreting others' social behaviors (see D'Entremont & Muir, 1997; Rochat & Striano, 1999; Rochat, Striano, & Blatt, 2002; Striano & Bertin, 2004; Striano & Liszkowski, 2005).

The current study shows that infants primarily utilize social cues to establish the meaning of interactions directed at them or away from them. The question of whether older infants would be more sensitive to the reference of others' social cues and then use this reference to interpret the meaning of others' behavior remains an open question. The current study provides a firm starting point to this question by showing that still at 4 months of age, infants may not read the underlying motive of the social signals in the same way as adults.

Future studies are needed to probe these developments further. For example, future research may determine if infants manifest the same pattern of responding if they encounter a positive or a negative expression directed at them or away from them (see Wicker et al., 2003). Establishing the mechanisms by which human infants interpret the relevance of social signals is also of critical importance in understanding disorders such as autism, which appear to modulate this skill.

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