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BRIEF REPORTS

Innate Intersubjectivity: Newborns' Sensitivity to Communication Disturbance

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In most of our social life we communicate and relate to others. Successful interpersonal relating is crucial to physical and mental well-being and growth. This study, using the still-face paradigm, demonstrates that even human neonates ($n = 90$, 3–96 hr after birth) adjust their behavior according to the social responsiveness of their interaction partner. If the interaction partner becomes unresponsive, newborns will also change their behavior, decrease eye contact, and display signs of distress. Even after the interaction partner resumes responsiveness, the effects of the communication disturbance persist as a spillover. These results indicate that even newborn infants sensitively monitor the behavior of others and react as if they had innate expectations regarding rules of interpersonal interaction.

Keywords: neonate, still-face, interaction, intersubjectivity

For more than 15 centuries philosophers have regarded newborn infants as incomplete, coming to the world with a blank mind (e.g., Aristotle, *De Anima,* III-4; trans. 1987) just to find it in a "blooming, buzzing confusion" (James, 1890/1981, p. 462). This view has had implications for the presumption that newborns and preterm neonates do not even feel emotions and pain. Over the last few decades the gradually accumulating knowledge on the neurophysiology of infants and data on their social competence has come as a surprise to researchers. Neonates' preference for human faces (Fantz, 1963) and for the voice (DeCasper & Fifer, 1980), the smell (McFarlane, 1975), and the face (Field, 1985) of their mothers, as well as their ability to imitate gestures and facial expressions (Field, Woodson, Greenberg, & Cohen, 1982; Meltzoff & Moore, 1977), have transformed our perception of the infant from incomplete to socially more competent.

Moreover, young infants not only participate in interactions but also sensitively detect and respond to disruptions of these social interactions during laboratory situations, such as the still-face paradigm (Tronick, Als, Adamson, Wise, & Brazelton, 1978; Tronick & Cohn, 1989). During the still-face experiment, the infant is exposed to a suddenly unresponsive interaction partner—the equivalent of freezing in the middle of a conversation. Infants as young as 2 months old decreased eye contact and showed increased negative affect not only as a response to the still face (Murray & Trevarthen, 1985; Rochat, Striano, & Blatt, 2002) but also as a response to even more subtle communication disturbances, such as the apparent noncontingent responsiveness of the mother when the mother's behavior was replayed to the baby with a delay using a double-video system (Murray & Trevarthen, 1985; Nadel, Carchon, Kervella, Marcelli, & Réserbat-Plantey, 1999; Reddy, 2003). Infants' reactions to the still-face procedure can be interpreted as evidence for their adaptive social competence from as early as 2 months of age.

Infants' reaction to communication disturbances undergoes development as the baby matures, however. In Rochat et al. (2002), when the experimenter adopted a "happy" still face for 20 s (that is, an unresponsive still face with a happy expression), 2-month-old infants' behavior was unaffected, whereas 4-month-olds reacted the same way as they did in the "blank," emotionless still-face situation. Ellsworth, Muir, and Hains (1993) reported that at 3 months, infants became upset when a person, but not an object, became unresponsive. Yet even at 6 months, infants do not react differentially according to the intention of the communication partner. For example, in the study by Delgado, Messinger, and Yale (2002), infants reacted with comparable distress when the experimenter looked at the infant with a still face and when the experimenter looked with a similarly blank, unresponsive face at a picture behind the infant. Thus, whether the experimenter's still face was directed toward the infant did not differentially affect the infants' responses.

Rochat et al. (2002) suggested that it is only from 4 months of age that babies start to respond to the still-face situation based on expectations of contingent social responses from the interactional partner, because infants become sensitive to the timing of the social interactions around that time (Rochat, Querido, & Striano, 1999). Younger infants may be slower to respond socially, however (Heimann, 2001), so that the 20-s still-face period employed

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in Rochat et al.'s (1999) study may have been insufficient to measure such changes. Bazhenova, Plonskaia, and Porges (2001) and Weinberg and Tronick (1996) found that 5- and 6-month-old infants' heart rate increased—indicating an elevated stress level—during the still-face period but returned to baseline level in the reunion period, which means that the still-face situation evokes complex psychophysiological responses.

The accumulating data on younger infants' social competence has demonstrated remarkable communicative capabilities even in newborn infants. Nagy & Molnar (2004) reported that human neonates not only imitate but also initiate communication, thus being able to participate in reciprocal interactions. In light of these advances in demonstrating newborns' communicative competence, it seems plausible that infants are sensitive to communication disruption much earlier than previously thought and examined—even from birth. Therefore, newborn infants' responses to the still-face paradigm could be comparable to those of older infants. This study aimed to determine whether newborn infants respond differentially to communication disturbance modeled by the still-face situation. It was predicted that infants would, even in the first days of their lives, selectively respond to the still-face situation. As a control, infants' behaviors across the still-face paradigm and a continuous communication paradigm of comparable length (without the disruption of the still-face phase) were compared. Similar to the results of Cohn and Tronick (1983) and Gusella, Muir, and Tronick (1988), it was predicted that newborns would react differently to the communication disturbance represented by the still-face paradigm than to continuous communication of a similar duration.

Method

Participants

Mothers of healthy, singleton newborns (Hungarian, Caucasian) requiring no neonatal intensive care were approached after delivery, and newborns of those mothers who agreed and signed the informed consent were included in the study.

Fifty-seven healthy newborn infants (27 boys, 30 girls) were examined with the still-face paradigm 3–96 hr after birth. Infants were born on average at 38.68 gestational weeks (SD = 1.48; 36–40 weeks), and their average weight was 3,363 g (SD = 460 g, 2,170–4,150 g). Thirty-nine were born by vaginal delivery and 18 by caesarean section.

A sample of 33 healthy newborn infants (21 boys, 12 girls) was examined in the control condition 4–96 hr after birth. Infants included in the control condition were born on average at 38.90 gestational weeks (SD = 1.08; 36–40 weeks); their average weight was 3,421 g (SD = 423 g, 2,330–4,200 g). Eighteen were born by vaginal delivery and 15 by caesarean section. All babies in both groups had a minimum Apgar score of 8 at birth and at 5 min, and they had a minimum score of 9 at 10 min.

Infants were randomly assigned to either the still-face or the control conditions. There were no differences between newborns in the still-face and in the control groups in weight, $t(88) = 0.59$, $p = .56$, gestational age, $t(88) = 0.74$, $p = .46$, type of delivery, $\chi^2(1, N = 90) = 1.71$, $p = .26$, or sex, $\chi^2(1, N = 90) = 2.22$, $p = .19$.

Procedure

The examination room, which was a separate but integral part of the neonatal ward, had constant illumination and an ambient temperature of 28° C; the conditions and environment of the room were the same for every newborn. Newborns were examined 30–90 min after feeding, which proved to be the optimal time for examining them in an awake but quiet state.

Infants were placed on an examination table in a newborn car seat, facing the experimenter, who stood in front of the infant. The experimenter's face was at the level of the infant's face at a distance of approximately 30 cm. The same experimenter conducted the study throughout. A Panasonic NVGS27B digital video camera mounted on a tripod behind the experimenter recorded the experiment. A mirror was placed behind the baby on the right side so that the experimenter could be seen by the video camera.

Although 120-s phases are most commonly used in this procedure (Adamson & Frick, 2003), the current study employed 180-s phases, similar to Tronick et al.'s (1978) original study, because of the potentially slower social responses of newborn infants (Heimann, 2001).

The still-face experiment started with a 3-min natural interaction (including both verbal and nonverbal communication) with the baby (Phase 1; P1), followed by a 3-min period when the experimenter became unresponsive (still face; SF) and displayed a neutral, silent, still face. Finally, for another 3 min the experimenter resumed the responsive interaction with the baby (Phase 3 or reunion phase; P3). Neonates in a control group were also examined during a 3 × 3-min (P1, P2, P3) continuous interaction, where the experimenter was continuously responsive to the baby (as if P1 in the still-face experiment continued throughout the three phases).

Coding

The entire experiment was coded with 1-s accuracy using the Noldus Observer-Pro 5.0 system (Noldus Information Technology; Wageningen, The Netherlands), a professional system used to record and analyze the temporal sequence and duration of behavioral events. Three phases were coded: P1, SF, P3 in the still-face experiment, and P1, P2, P3 in the control experiment.

The amount of time (duration: % of observation) infants spent looking at the experimenter (gaze behavior) was coded as approach behavior. Distress behaviors (such as showing distressed face and crying) and self-regulatory behaviors (such as sucking fingers, hands, or mouth and sleeping) were coded.

Reliability Coding

To assess interobserver agreement, 34% (one third, n = 31) of the data was recoded (randomly assigned among the three coders, for all variables) for reliability. Overall, an 81% interrater reliability with k = 0.76 was attained.

Results

The data were analyzed using a mixed design repeated measures analysis of variance with behavior (on three levels: P1, P2/SF, P3) as within-subject and condition (still face/control) as between-subject factors.

Gaze Behavior

Overall, babies gazed at the experimenter the same amount of time in the still-face condition as in the control condition, $F(1, 89) = 1.87$, *ns*. There was a significant main effect of gaze across the three phases (with Greenhouse-Geisser correction, $F(1, 88) = 10.92$, $p < .001$), and a significant Gaze × Condition interaction (with Greenhouse-Geisser correction, $F(1, 88) = 4.81$, $p < .01$; see Figure 1).

Further pairwise comparisons (adjusted according to the Bonferroni method) showed that babies in the still-face condition significantly decreased their eye contact in the still-face (SF) phase compared to P1 (P1: $M = 16.59$, $SD = 11.70$; SF: $M = 8.26$, $SD = 7.33$, $p < .001$), and eye contact remained low in P3 (SF: $M = 8.26$, $SD = 7.33$; P3: $M = 10.71$, $SD = 9.53$; SF:P3, *ns*). In P3, babies maintained less eye contact than in P1 ($p < .001$).

However, controls did not change their gaze behavior from P1 to P2 (P1: $M = 15.68$, $SD = 15.37$; P2: $M = 14.50$, $SD = 13.49$, *ns*) or from P2 to P3 (P3: $M = 11.80$, $SD = 11.36$, *ns*). Likewise, there was no significant difference between P1 and P3.

Distressed Face

Overall, babies in the still-face condition displayed distressed face for a significantly longer time than babies in the control condition did—still-face condition, $M = 4.12$, $SD = 0.59$; control condition, $M = 0.85$, $SD = 0.78$, $F(1, 89) = 11.23$, $p = .01$.

The amount of time babies spent displaying distressed face did not differ across the three phases (with Greenhouse-Geisser correction, $F(2, 88) = 2.32$, *ns*). There was, however, a significant Distressed Face × Condition interaction (with Greenhouse-Geisser correction, $F(2, 88) = 3.68$, $p < .05$; see Figure 2).

Further pairwise comparisons (adjusted according to the Bonferroni method) showed that babies in the still face condition significantly increased the duration of displaying distressed face in the SF phase compared to P1 (P1: $M = 1.90$, $SD = 4.13$; SF: $M = 5.33$, $SD = 8.54$, $p < .001$), and they maintained this high level of distress in P3, which was comparable to SF (P3: $M = 5.12$, $SD = 8.34$; SF: $M = 5.33$, $SD = 8.54$, *ns*). Babies displayed distressed face significantly longer in P3 than in P1 ($p < .001$).

The amount of time babies spent displaying distressed face in the control condition did not differ across P1, P2, and P3, however (P1: $M = 1.05$, $SD = 4.50$; P2: $M = 0.60$, $SD = 1.72$; P3: $M = 0.74$, $SD = 1.86$).

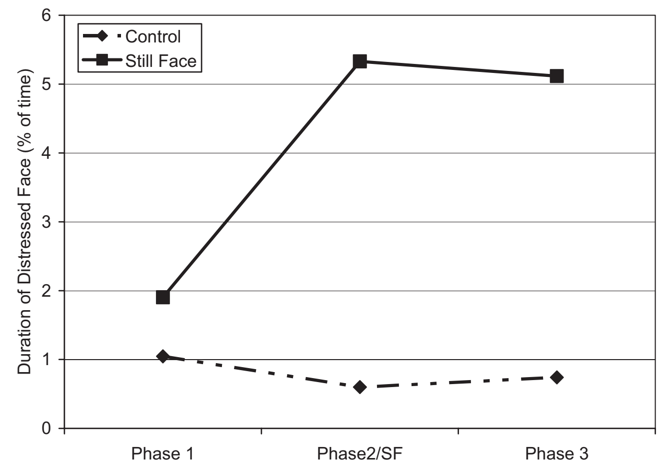

Figure 2. Duration of distressed face in still-face (SF) and control conditions.

Crying

Overall, babies cried for the same amount of time in the still-face condition compared to the control condition, $F(1, 89) = 2.17$, *ns*.

The amount of time babies spent crying did not differ across the three phases (with Greenhouse-Geisser correction, $F(2, 88) = 1.05$, *ns*). There was, however, a significant Crying × Condition interaction (with Greenhouse-Geisser correction, $F(2, 88) = 4.6$, $p < .05$; see Figure 3).

Pairwise comparisons (adjusted according to the Bonferroni method) showed a tendency for babies to cry for a longer time in the SF phase compared to P1 (P1: $M = 1.13$ $SD = 3.40$; SF $M = 3.57$, $SD = 9.31$, $p = .08$), and they maintained a comparably high amount of crying in P3 (SF: $M = 3.57$, $SD = 9.31$; P3: $M = 5.82$, $SD = 13.08$, *ns*). The duration of crying was significantly longer in P3 than in P1 ($p < .001$).

The amount of time babies spent crying in the control condition did not differ across P1, P2, and P3 (P1: $M = 2.71$, $SD = 13.90$; P2: $M = 0.15$, $SD = 0.71$; P3: $M = 0.78$, $SD = 2.51$).

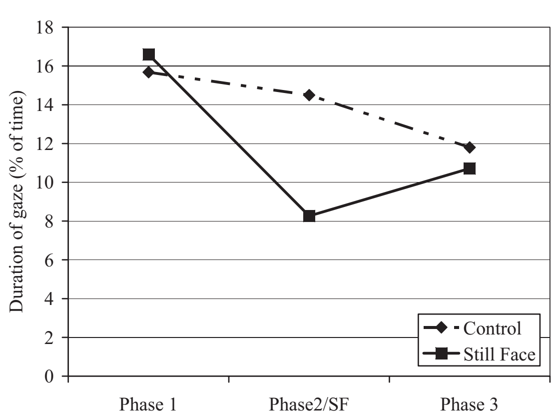

Figure 1. Gaze behavior in still-face (SF) and control conditions.

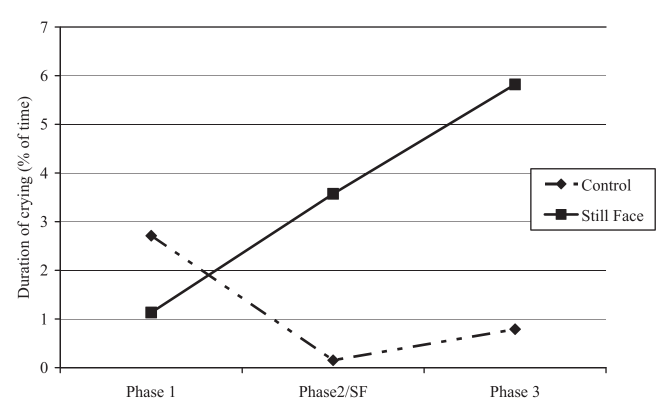

Figure 3. Duration of crying in still-face (SF) and control conditions.

Sucking

Overall, the duration of sucking did not differ in the still-face condition, compared to the control condition, $F(1, 89) = 2.15$, *ns*. The amount of time babies spent sucking did not significantly differ across the three phases (with Greenhouse-Geisser correction, $F(2, 88) = 2.48$, $p = .09$), and there was no significant Sucking $\times$ Condition interaction (with Greenhouse-Geisser correction, $F(2, 88) = 0.31$, *ns*).

Sleeping

The duration of sleeping did not differ in the still-face compared to the control condition, $F(1, 89) = 1.53$, *ns*). The amount of time babies spent sleeping was different across the three phases (with Greenhouse-Geisser correction, $F(2, 88) = 5.37$, $p < .01$), but there was no significant Sleeping $\times$ Condition interaction (with Greenhouse-Geisser correction, $F(2, 88) = 0.55$, *ns*).

Pairwise comparisons adjusted according to the Bonferroni method showed that babies spent more time sleeping in the SF compared to the P1 phase in the still-face condition (P1: $M = 5.77$, $SD = 18.35$; SF: $M = 10.27$, $SD = 27.46$, $p < .05$), and they had a tendency to decrease the amount of sleep in P3 (SF: $M = 10.27$, $SD = 27.46$; P3: $M = 5.62$, $SD = 18.11$, $p = .06$). The amounts of time spent sleeping in P1 and P3 in the still-face condition were comparable. However, the amount of time babies spent sleeping in the control condition did not differ across P1, P2, and P3 (P1: $M = 10.09$, $SD = 24.47$; P2, $M = 15.08$, $SD = 28.54$; P3: $M = 12.86$, $SD = 29.50$).

Discussion

Overall, the results of this study showed that the still face of the experimenter did have a consistent and differential effect on the newborns' behavior. Newborns changed their gaze behavior, showed distressed face, and cried differently across the three phases depending on whether they experienced the still-face paradigm or continuous communication for a comparable period. Specifically, newborns decreased their eye contact with the experimenter, showed increased negative affect (i.e., showed distressed face and cried more), and showed more self-regulatory behaviors (i.e., slept more) during the still-face phase. Similar to the spillover effect described by Tronick et al. (1978) in older infants, neonates in this study continued to display higher levels of distress and crying and a lower amount of eye contact in the reunion period than at the beginning of the experiment. They also showed a tendency to decrease the amount of time spent sleeping from the still face to the reunion period to a level comparable to their baseline. No phase-related changes were observed during the control condition in the continuous communication experiment.

In the current study, similarly to previous studies of older infants (Tronick & Cohn, 1989; for a review, see Adamson & Frick, 2003), newborns showed increased negative affect and decreased eye contact during the still-face phase, with a low level of eye contact and a high level of negative affect, as a spillover effect, during the reunion phase. Comparison with a control situation of the same length showed that the behavioral responses of the newborns were specific to the still-face situation and not merely the result of tiredness or inattention.

When interpreting the meaning of the still-face situation for infants, early theories assumed that infants respond to the still-face situation negatively because it is discrepant from already learned schemes (Kagan, 1975) or violates infants' expectations on interaction (Field, 1985; Tronick et al., 1978), and that they therefore lose their predictive control over the interaction situation (Watson, 1977). Later theories (Murray & Trevarthen, 1985; Rochat et al., 2002) proposed that during the still face paradigm, babies are likely to detect the noncontingent behavior of the communicative partner. The contingent responding of the communication partner sets the basis for the developing interpersonal self-efficacy, whereas the noncontingent responding of the interactional partner may be perceived as stressful interpersonal interaction by the infants (Murray & Trevarthen, 1985; Tronick & Cohn, 1989).

Gergely and Watson (1996, 1999) suggested that infants are born with spatial and temporal contingency detection modules and that the feeling of contingency is positive (Tarabulsky, Tessier, & Kappas, 1996); thus, the lack of contingent temporal responding can violate newborns' expectations. Gergely and Watson (1999) also pointed out that in the very first initial social interactions not the infant but only the caretaker responds in a contingent way; it is only from 3 months of age, when infants develop their interpersonal sense of self, that they recognize other people as similar to themselves. Similarly, Rochat (2001) proposed that infants start to develop an interpersonal sense of themselves only after 2 months of age, after the self–world perceptual discrimination has evolved; this therefore means that the primary need for interpersonal interaction cannot explain the neonate's responses to the still-face situation.

Newborn infants in the present study were distressed not only for the period of the communication disruption but even after the contingent responding of the experimenter had been resumed. Moreover, the communication disruption in this study was different from noncontingent responding, but it was a nonresponding presence from the experimenter; therefore, newborns' reaction to the situation must have further explanations.

Hofer (1994) proposed that the adult has an external regulatory role on the infant, and in general, mammalian mothers have a substantial role in regulating various physiological and neurophysiological functions that the infant is not able to regulate initially (Kraemer, 1992). Fogel (1993) and Tronick (2003) advanced Hofer's theory to the coregulatory (Fogel, 1993) and mutual regulatory model (Tronick, 2003), suggesting that the infant–caretaker dyad is mutually regulated. During communication, the communicative partner, as a secure base, becomes the source of biobehavioral regulation for the infant (Weinberg, Tronick, Cohn, & Olson, 1999). Tronick, in his dyadic states of consciousness model (Tronick, 2005), regarded both the infant and the interaction partner as open psychobiological systems that must interact to maintain their coherence, increase their complexity, and reduce their entropy. According to this model, in the still-face situation, when the adult disconnects from the infant, the infant's behavior returns to a less organized level as a result.

The infant's capacity to regulate his or her own state is limited, however. Thus, in the laboratory-simulated disruption of the regulatory control by the other during the still-face phase, the infant attempts to repair the interaction, and when this fails, engages in self-regulatory behaviors. Failure to self-regulate his or her state will result in increasing negative affect in the still-face stage. As Tronick and colleagues (Tronick et al., 1978; Tronick, 2003) described, because of the conflicting spillover of negative emotions and the positive affect evoked by the reinstated communication, the reunion period is still difficult for the baby to regulate. Indeed, the increased negative affect and the decreased eye contact during the still-face phase and their spillover (instead of decrease) during the reunion periods in this study gives support to the regulatory model as a mechanism of neonates' reaction to the communication disturbance.

Most behavioral responses to the still-face situation could be interpreted as part of a complex adaptive coping regulatory process. For example, gaze aversion as measured during the still-face phase and the reunion periods is known to be effective in reducing autonomic arousal and negative affect (Field, 1981; Harman, Rothbart, & Posner, 1997). In the current study, even newborn babies showed gaze aversion during the still-face situation. Additionally, the increase in the time newborns spent sleeping during the still-face phase may indicate babies' increasing attempt to self-regulate.

The present study with young neonates raises the question of the significance and the meaning of the communicative situation in this paradigm. Although the mutual regulatory model and the dyadic states of consciousness theories (Tronick, 2003, 2005) imply that communication is a means of coregulation, Trevarthen and colleagues (Trevarthen, 1977, 1991; Trevarthen & Aitken, 2001) proposed that intersubjective communication is a primary motive, implying that disruption of communication and not simply the lack of the external regulation causes the distress.

It is interesting that various types of disengagement were not found to have an equal effect on infants. Murray and Trevarthen's (1985) study compared the "interrupted communication" paradigm (i.e., someone else started to talk to the mother in place of the still-face manipulation, thus interrupting the mother–infant communication) to the noncontingent responding situation; data from the study showed that even though the interruption changed the communication, it was not distressing for the infants, whereas the noncontingent responding was. The model of mutual regulation of the interactional partners in Murray and Trevarthen's study therefore cannot be the sole mechanism responsible for their results or those of the present study, but rather implies that the need to communicate is a primary motive in infants.

A relative limitation of the study is that although the coders were blind to the goal of the experiment and were not familiar with research in this area, the videos displayed both the experimenter and the baby. Future studies with separate recordings for the experimenter and the baby, or alternatively, using masked video-records, could overcome this limitation. In addition, future studies could benefit from the use of more objective measures, such as eye-tracking. A possible methodological problem with such experiments was referred to as the still-face and still-person effects by Muir and Lee (2003). Although it has been shown that the true still-face effect can be elicited without using touch (Ellsworth et al., 1993; Gusella et al., 1988; Muir & Hains, 1999), we do not yet have the same evidence about the role of the vocalization in the still-face period. Further studies are needed to separate the role of the changed vocalization and the role of the still face in such paradigm.

In summary, the complexity of newborns' reactions to the still-face situation, as well as the similarity between their behaviors and those of older infants during this situation, indicates a presumably innate motivation to engage in interactions with others, and this motivation may serve to further the ability of adaptive contextual self-regulation as early as their first relationships.

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