



Infant Regulation of Distress:
A longitudinal study of transactions between
mothers and infants

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List of papers

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Abstract

Attachment theory has emphasised how important sensitive and prompt caregiving is for the development of attachment between the child and the caregiver, and how attachment-related processes contribute to the development of the child's self-regulation skills. In contrast, theories of temperament has emphasised intra-individual differences, such as biological differences in reactivity and regulation. The transactional model describes the development of relational history between the caregiver and the infant as individual-environmental transactions that also involve the development of emotional regulation skills in the infant. These transactions were investigated in a sample of fifty mothers and infants who participated in five studies that took place from the infants were 2 to 17 months of age. To test the transactional model empirically, the project has focused on factors related to infants' social skills and biological characteristics, sensitive caregiving, context, and on the interplay between these factors during distressing events. Early social communication skills in infants were evidenced as sensitivity to violation of social contingency during face-to-face communication with the mothers, but only among infants who expressed few signs of negative affect (Paper I). Then, mothers' sensitivity to violation of social contingency during face-to-face interaction was investigated as a further test of infants' social contribution to social interactions. Mothers' Infant Directed speech was found to depend on the quality of infants' responsiveness, which then suggests that infants are actively involved in early interaction (Paper II). It was then found a non-linear relation between maternal soothing and infants' distress responses to acute pain, and early attentional control in the infants were found to correspond with maternal soothing behaviour. The results suggest that biological and context-dependent maternal and infant responses to distressing events are mutually regulated (Paper III). The transactional hypothesis was empirically confirmed when combining data from a short longitudinal time interval (data from the infants at 2 months and at 3 months), but not when prolonging the time interval of the longitudinal analyses to include the infants' distress responses at 3-, 15-, and 17 months of age (Paper I, Paper II, Paper III, Study 4, Study 5). It is suggested that future research should explore combinations of early multiple factors involved in the development of infant regulation skills.

1. INTRODUCTION

1.1. Theories of caregiver-infant interaction

1.1.1. Attachment theory

In the fifties, John Bowlby introduced attachment theory to psychological science. Bowlby's (1951) major claim was that a child's mental health is dependent on the experience of a warm, intimate and continuous relationship with a primary caregiver. The nature of the child's tie to the caregiver is explained from an ethological approach (Bowlby, 1988). The concept "attachment" defines the emotional tie which develops between the infant and his/her primary caregiver (Bowlby, 1988). The infant's need for attachment is related to pre-dispositions that motivate the infant to seek intimate relationship for security, and derives from genetic selection that evolved in a time when humans lived in what Bowlby called "the environment of evolutionary adaptedness" (Bretherton, 1992; Cassidy, 1999). Attachment behaviour is specific behaviour which increases proximity to the attachment figure or which maintain established proximity to the attachment figure (Bowlby, 1969; 73). This is regarded as a pre-programmed set of behaviours activated by certain conditions, such as when the caregiver is out of sight, novelty, loud noise, hunger or other distressing states or situations. Such conditions are not necessarily harmful in themselves, but they are related to the potential threat of danger and stress (Cassidy, 1999). In the same manner will certain opposite conditions, such as closer proximity to attachment figure, terminate attachment behaviour.

During infancy, fretting and crying to gain proximity or smiling and following the caregiver to maintain closeness are examples of attachment behaviour. The infant's attachment behaviour will in turn arouse the caregiving behaviour system in the caregiver (Bowlby, 1988). Even if infants are pre-programmed to connect with caregivers, it is proposed that the development of the quality of attachment relationship depends on sensitive and contingent parenting (see Ainsworth, 1991) and that the primary caregiver becomes the primary attachment figure in the child's life. Consequently, even if every child and caregiver develop attachment relationship, there are also individual differences in the quality of these relationships (Weinfield, Sroufe, Egeland & Carlson, 1999).

The attachment pattern which is observed in one year olds continues as a stable characteristic of the relationship (Bowlby, 1988). One reason for this is the stability of parents' behaviour which, through internalising processes, has become working models of the attachment relationship and a part of the child's personality (Bowlby, 1973). For

example, a child who experiences that the caregiver is available when needed, will develop an internal working model of an available parent and thus be less susceptible to fear and stress than a child who does not have such a model. Correspondingly, when the caregiver satisfies the child's needs for care in a stable and contingent manner, the child will also develop an internal working model of the self as loved and valuable. Bowlby (1988) describes the processes as "developmental pathways" in a particular child's personality development.

1.1.2. Recent advances in attachment theory

A more recent version of the attachment theory includes a neuroscientific approach to the development of the child's adaptive social and emotional functions and a focus on the dyadic psychobiological interplay between the infant and his/her caregiver (Schoore, 2001). This perspective addresses a more fundamental and detailed hypothesis regarding the importance of an emotional attachment relationship during early years of life, and its impacts on brain structures which mediate psychological development (Schoore, 1994). Reflections of changes caused by alterations of neurological functions can be observed in infants' physical growth and motor activity, but also in their perceptual discrimination, attentional preferences and affectional and cooperative engagement with caregivers (Trevarthen & Aitken, 2001). This neurological maturation depends on interpersonal experiences during the child's first years, where both the quality and quantity of the experiences have great impact on how neural circuits grow and develop. This involves neural circuits responsible for emotional and social functions, which also influence the development of more complex systems such as memory, behaviour and interpersonal relationships (Siegel, 2001). Consequently, human connections form neural connections (Siegel, 1999).

This perspective implies that sensitive and collaborating emotional communication between the parent and the infant, with repeated episodes of attachment transactions, will be encoded in implicit memory as expectations, and later on as representational models of the attachment relationship (Siegel, 1999). Together, this sets the "frame" for the dyad's relational history (see also Legerstee and Varghese, 2001). Thus, recent advances in attachment theory propose that interpersonal experiences during the first years of life have long-lasting and powerful impacts on mental models of our self and others (Siegel, 2001).

However, it is still debated to what extent young infants are socially skilled to regulate an interaction which goes beyond a mere primitive reflexive behaviour repertoire. While attachment theory has emphasised sensitivity and contingent parenting as the main factors promoting the development of secure versus insecure attachment relationships (see Ainsworth, 1991), other researchers have brought into focus the infant's own contribution. Although fragmentary, during the first weeks after birth the infant displays a range of communication skills which influence the caregiver and the relationship (Reddy, Hay, Murray & Trevarthen, 1997).

Emotional communication between infant and caregiver.

Bullowa (1979) defined non-verbal behaviour to include the range of extra-linguistic human communication skills. Non-verbal behaviour such as facial expressions (Lewis, 1978), eye gaze (Trevarthen, 1982), vocal intonation (Fernald, 1992; Panneton Cooper, Abraham, Berman & Staska, 1997), bodily motions (Trevarthen, 1984) and the attunement of responses (Tronick, 1989), are affective expressions. Such behaviour serves as external expressions of the individual's internal emotions, and the non-verbal behaviour is considered as the primary mode by which emotions are communicated between infants and caregivers (Siegel, 1999). Siegel (1999) also suggests that affects are the external display of states, or changes of states, in the individual's arousal system. When an internal state or a change of states is externally observable as affective expressions and behaviours, this suggests that two persons who are communicating in an attuned interaction, will be able to "feel" each other's experiences. This "mind-reading" skill can also be labelled as "empathy", "mirroring" or "intersubjectivity" (Trevarthen, 1979; 2001). Thus, emotions serve important functions in how we perceive each other's intentions, focus of attention, as well as experiences of the interaction or shared event. The regulatory function of non-verbal communication implies that affective expressions inform each of the partner's about the other's acceptance, rejection or modification of the current state of the interaction (Brazelton, 1982).

In the 70's, researchers from different research fields reported detailed observations and descriptions of infant behaviour during face-to-face interaction with the mother. From observations of brief, slowed down communication sequences with infants and their mothers, it was found that the infants' behaviour were highly organised and coordinated in head, eyes, arms, hands, and vocalisations (Bateson, 1979). The phenomenon was called "protoconversation". Further, Bateson (1979) reported that

mothers and infants were collaborating in a pattern of alternating and non-overlapping vocalisations, where both partners actively made an effort to continue the communication, or to restore communication that failed.

Collaborating research fields have established new insights into infants' social skills in interpersonal communication. Along with the neuroscientific approach and the acknowledgement of the psychological importance of dyadic events, there is now a strong support for the view put forward during the 70ths.

1.1.3. The theory of intersubjectivity

Colwyn Trevarthen has developed a theory that proposes that young infants have innate motives for communication and collaboration, seen as a readiness for social belongingness. This theory departs from the view of traditional attachment theory which says that infants seek closeness to caregivers for the purpose of protection. In his theory, Trevarthen (2001) postulates that infants are born with innate motives, where motives refer to structured states which specify the form of the infant's actions as well as the context where the actions takes place. Furthermore, Trevarthen (1980) argues that innate motives for intersubjective sharing can be observed in the infant's timing and emotional tone during communication, and that the infant is aware of the initial subjective state of another person (Trevarthen & Aitken, 2001).

The term intersubjectivity recently entered the philosophical/psychological discourse (Malpas, 2002). Broadly defined, intersubjectivity refers to sharing of minds (Kokkinaki & Kugiumutzakis, 2000), realm between subjects (Malpas, 2002), patterns of interactive regulation (Beebe, Knoblauch, Rustin & Sorter, 2003) and attunement of subjects mental- and emotional processes (Trevarthen, 1979). Intersubjective sharing refers to the non-verbal mode of actions: It is not rule-governed, and neither the structure nor the verbal content is important. Thus, the crucial function is the sharing of emotions and understanding, and the synchronisation to the companion's subjectivity (Trevarthen, 1979).

Due to the theory of intersubjectivity, early communication is a process of mutual social awareness between infant and caregiver which involves sensitivity to timing (Bloom, 1993) and awareness of presence or absence of reciprocity (Rochat, Neisser & Marian, 1998). It is suggested that the infant has the capacity to perceive events in time and space, to perceive facial and vocal affect together with the sensation of it's own arousal (Beebe, 2000), and to experience his/her own agency (Russell, 1999). These

social skills are called pre-symbolic intelligence (Beebe, 2000) or social intelligence (Trevarthen & Aitken, 2001), and are suggested to foster secure attachment (Siegel, 2001).

Neonatal imitation is the earliest and perhaps most striking illustration of innate intersubjectivity. The newborn can imitate a model soon after birth (see Heimann, 2002). Nagy and Molnar (2004), who examined the interactive nature of imitation, found that infants less than two days old did not only respond with imitative behaviour, but also initiated tongue protrusion to provoke a new response from their adult partner. From a developmental perspective, imitation serves important socialisation functions (Užgiris, 1999), and imitation of significant models' (caregivers') expressions, mannerisms, vocal intonations and belief systems are related to cultural learning (see Trevarthen, 2003).

The progressive levels of intersubjectivity are specified as primary intersubjectivity and secondary intersubjectivity (see Beebe et al. 2003; Trevarthen, 1979). Primary intersubjectivity is manifested in the infant's significant interest in face-to-face communication around 5 to 6 weeks of age (Trevarthen, 1982), and refers to the coordination of the self with the partner's self. During this phase, infants' motives and interests are mainly directed towards persons. Even if infants show attention to objects, they behave differently towards inanimate objects which they deal and handle, than towards persons with whom they communicate (Trevarthen, 1980). However, signs of developmental changes become visible when infants approach 4 months of age. From this age, infants more often break the visual contact with the caregiver to explore inanimate objects instead. The infants depend on and enjoy company with the caregiver, but face-to-face contact is more often rejected in favour of dealing with objects (Trevarthen, 1980). This division of motives and interests seems to lead to a combined intentionality, known as the phase of secondary intersubjectivity. Now the infant actively invites the caregiver to take part in joint interaction on a common topic. So, while primary intersubjectivity refers to the coordination of self and others, secondary intersubjectivity refers to the coordination of self, others and objects (Beebe et al., 2003). These processes occur at the same time as important brain structures mediating social and emotional functioning have their most rapid development (Schorre, 1994).

Despite the relative asymmetry between the infant's capacity for self-regulation and other-regulation (Sameroff, 2004), it is not only external regulation of physiological processes which motivates the infant's to relate to the caregiver (Trevarthen, Kokkinaki & Fiamenghi, 1999). The main conclusion from the theory of intersubjectivity is that

infants have an intrinsic psychobiological capacity to integrate perceptual information from several modalities (see Trevarthen & Aitken, 2001) and that they are able to detect (emotional matching) and change other's behaviour by purposeful emotional expressions (Gianino & Tronick, 1988; Trevarthen & Aitken, 2001), although this capacity is more fragile during the first weeks after birth.

From what we know about newborn skills in neonatal imitation and protoconversation, human brains are formed to integrate expressive body movements of face, hands and mouth, with corresponding motives of the partner. This indicates that there is a complex adaptive body-mapping and body-motivating system before birth (Trevarthen et al., 1999), which is specified and structured by the newborn's brain and neuromotoric organs (Trevarthen, 1998). From a neuroscientific perspective, mirror neurons located in premotor cortex might be the basic organisational principle in the brain which enables intersubjective experiences (Gallese, 2003).

1.2. Distress and coping in infants

Since distress is unavoidable for all humans, coping with distress is a significant developmental task for infants. Infant distress and pain experiences are relatively new research topics (Gillman & Mullins, 1991; Ross & Ross, 1988), and the research field is complex, since infants' responses to stress vary. The field requires methods and assessments which fit a non-verbal population. Besides the fact that the magnitude of the stressor will influence the response, mediating factors such as the infant's social environment (caregivers), constitutional factors and developmental level should be considered in research questions, assessments and interpretations.

1.2.1. Theories of distress and coping during infancy

Theories of infants' regulation of distress have been dominated by attachment theory and theories of temperament (Pierrehumbert, Miljkovitch, Plancherel, Halfon & Ansermet, 2000). According to Rothbart and Derryberry (1981), temperament could be defined as biological differences in reactivity and self-regulation, which are linked to underlying neural systems (Posner & Rothbart, 1998). The idea is that a central attentional mechanism is involved in the control of both emotional and cognitive processes related to the individual's responses to distress and negative affect (Rothbart, Posner & Rosicky, 1994). This idea was supported in a study which found a positive correlation between infants' efficacy to inhibit attention and duration of distress responses to painful

stimulation (see Axia, Bonichini & Benini, 1999). Thus, temperament can be viewed as individual differences in regulating experiences. This calls for defining temperament more as a relational phenomenon (see also Sameroff & MacKenzie, 2003a) rather than a trait inherent in the child.

Attachment theory has provided insight into the impacts of caregivers' situational behaviour on the development of attachment patterns (Ainsworth, 1982). The caregiver's presence (Ross & Ross, 1988) and vocal-related coping behaviour (Sweet & McGrath, 1998; Sweet, McGrath & Symons, 1999) have been found to influence the child's responses to distress, and attachment theory acknowledge that the caregiver's sensitivity and promptness contribute to the infant's emerging pattern of self-regulation (Lyons-Ruth & Zeanah, 1993).

Nevertheless, rather than viewing theories of temperament and attachment as contrasting perspectives, Pierrehumbert et al. (2000) suggest that both temperament and attachment are factors involved in emotional regulation. The quality of caregivers' regulation of infants' emotions and behaviour may influence how effective they are in handling and meeting infants' needs in distressing situations (Carey, 1999). However, an accumulated perspective on the relation between caregivers' behaviour and infants' responses to distress will also includes their relational history, the here-and-now context and the infants' reactivity and regulation responses during acute pain.

Kopp (1989) supports this view when she suggests three principles that facilitate the development of emotional regulation. First, emotional regulation involves a flexible action system to reduce distress. Second, emotional regulation is adaptive, with pre-adapted programs of cognitive processes such as expectation of cause and effect as well as more advanced cognitive processes that involve planning, organisation and monitoring. The third principle is that infants and small children must have external support for emotional regulation. These principles are closely linked to skills that develop and emerge at different times during the first year of life. Kopp (1989) suggests that the cognitive processes depends on early social-emotional processes between the infant and the caregiver, and that cognition-related emotional regulation becomes more important during the developmental course.

Bowlby did not emphasise differential emotional experiences or expressions, but focused more on the feelings of security and insecurity more than on emotions as such (Magai, 1999). Today, in terms with the theory of intersubjectivity, emotional communication is seen as inherent in the attachment between the infant and the caregiver

(Siegel, 1999). This is not only evident in infants' emotional signal to caregivers during distress, but also in happy conversation that young infants find motivating to take part in (see Trevarthen, 2003; Tronick, 2003). It is in the proximal relationship they learn about each other's thresholds for arousal and regulation capability. Tronick and colleagues (Gianino & Tronick, 1988; Tronick, 2003; Weinberg & Tronick, 1994) also suggest that there is an expressive flexibility that allows infants to adjust their behaviour and affect to different contexts. This is not necessarily evident in facial expressions alone, but should rather be viewed as coherence over modalities which are specific to events (Weinberg & Tronick, 1994).

1.2.2. Experimental testing of infants' interpersonal distress

An important factor in all communication is the expectation of social contingency; the expectation that the companion during communication will act and produce responses which are contingent in time and rhythm (see also Bloom, 1993). A second skill is detection for distinct differences in the quality of contingency in the partner's communicative responses. For example, from the theory of intersubjectivity one can outline that infants have formed expectations about the timing of behavioural responses as well as an awareness of presence of reciprocity. A third skill is the ability to re-establish communication when it has broken down. Tronick (1989) suggests this skill to be crucial for the development of emotional regulation. Thus, the detection for distinct differences in the quality of contingency in the caregiver's communication should consequently lead to changes in the infant's and the caregiver's interactive behaviour.

During normal interaction in a natural context, it can be difficult to identify the specific factors of each partner's behaviour which contribute to the harmonious dialogue between them (Murray, 1998), and to find out if infants show regulation capacity during the interaction. This has now been resolved experimentally, and together with advances in film and video technology it has become possible to introduce different perturbation experiments which analyse the consequences of intersubjective breakdowns. The so-called Still Face paradigm provides a framework (see Murray & Trevarthen, 1985; Tronick, Als, Adamson, Wise & Brazelton, 1978) where a sensitive adult such as the caregiver, is in face-to-face position with the infant and poses an expressionless face immediately after a sequence of normal interaction. The Still Face condition is found to elicit an initial form of protest and signs of distress in the infant, which usually ends with the infant withdrawing attention by gaze aversion (Murray & Trevarthen, 1985). The Still

Face procedure provokes an absolute non-contingent condition. However, it is hard to tell if the infant's responses really reflect detection of different contingency in the mother's behaviour. The responses may be provoked by the distressing nature of the experience (Nadel, Charcon, Kervella, Marcelli & Réserbat-Plantey, 1999).

Testing of more detailed aspects of infants' sensitivity to contingency in mothers' communication became possible through the development of the Double Video (DV) paradigm (see Murray & Trevarthen, 1985). Technically, the DV set-up is a two-way closed-circuit video system where the mother and the infant receive a full face life-size image of each other, which permits either for a live, real time communication, or a replay sequence of the partner's previous behaviour (Murray, 1998; Murray & Trevarthen, 1985). Compared to the Still Face design, the DV design enables a more subtle testing of infants' expectation for social contingency. The live, real time sequence constitutes the contingent aspects of normal communication, where the mother and the infant are able to take part in mutual conversation. The following replay sequence, where one partner receives a video recording of the other partner's previous behaviour, is a non-contingent situation. While the Still Face procedure represents a cut-off shift in the caregiver's verbal and facial behaviour, the DV procedure distorts the rhythm and contingency by setting the conversation out of phase. Even if the two procedures provoke two different kinds of experienced perturbation, both procedures can be defined in terms of interactive distress (see Gianino & Tronick, 1988).

Murray and Trevarthen (1985) reported that four 6-12 weeks old infants who communicated with their mothers in a live sequence, showed clear patterns of negative affect and withdrawal in the subsequently replay sequence. However, several critical questions have been raised both to the interpretations of the results and to the experimental design. While Trevarthen and Murray (1985) explained the infants' responses to perturbation of contingency in terms of sensitivity to changes in quality of mothers' communication, others claimed that the infants' responses could be due to increased fussiness over the time course (Rochat et al., 1998), familiarity of the adult (Hains & Muir, 1996), a carry over effect (Bigelow & Birch, 1999), expectations of certain amounts of non-contingent behaviour from the mothers (Bigelow, MacLean & MacDonald, 1996), or differences in the extent to which the mothers mirrored the infant's affect (Legestee & Varghese, 2001).

In an attempt to answer the "familiarity"- hypothesis, Hains and Muir (1996) examined twenty-eight 5 months old infants who were equally divided into an

experimental group who received a Live-Replay-Live design and a control group who received a Live-Live-Live design. The experimental group evidenced a significant decline in gaze and smiling in the replay sequence compared to the previous live sequence, with no recovery in gaze and smiling in the last live sequence. A similar decline in gaze and smiling was found in the control group. Rochat et al. (1998) criticized Murray and Trevarthen's (1985) for letting the initial live sequence endure until the mothers and infants engaged in happy communication, while the subsequent replay sequence was much shorter. Fatigue produced by the length of the live sequence could explain why infants were less engaged in interaction in the replay sequence. In an attempt to control for this, Rochat et al. (1998) introduced fixed timing of both the live and the replay sequences in two experiments with 2-, 3-, and 4 months old infants communicating with their mother. They did not find any increase in infant gaze at mother during the live- compared to the replay sequence. Rochat et al. (1998) concluded that Murray and Trevarthen's (1985) findings of sensitivity to social contingency in young infants could reflect flaws in the experimental design rather than a real psychological phenomenon.

It could, however, be argued that neither Hains and Muir (1996) nor Rochat et al. (1998) took Trevarthen's theory of intersubjectivity fully into account. The DV set-up is designed for infants who are engaged in protoconversation (Trevarthen & Aitken, 2001), face-to-face with their caregiver (Trevarthen, 1982) in the phase of primary intersubjectivity. The infants in Hains and Muir's (1996) study were slightly too old to capture the peak of protoconversation, and Rochat et al. (1998) introduced fixed time exposure without controlling for if the mothers and the infants had reached a state of mutual communication in the first live sequence. So what has meant to be a comparison of infants responses between live- and replay sequences might in fact have been a comparison between two non-contingent interactions (see also Nadel et al., 1999). Communication between caregiver and infant is hardly fixed, but should rather be seen as flexible processes of co-creation of meanings of "what to do" and "how to be together" (Tronick, 2003).

However, both Nadel et al. (1999) and Stormark and Braarud (2004) replicated Murray and Trevarthen's (1985) findings. Even more importantly, they found that the infants evidenced an increase in communicative behaviour during a second (Nadel et al., 1999; Stormark & Braarud, 2004) and a third live sequence (Stormark & Braarud, 2004), compared to the preceding replay sequence.

1.2.3. Experimental testing of caregivers' regulation of interpersonal distress

Caregivers display multimodal emotional expressions during interaction with their small infants. During protoconversation, they communicate with physical touch, gaze, vocalisation and affective facial expressions, and compared to adult-to-adult communication, caregivers show vocal and facial expressions which are exaggerated in form and rhythm (Stern, 1974). Few studies have explored how violation of expectancy during early communication influences behaviour in caregivers. When face-to-face communication is experimentally manipulated in Still Face studies, caregivers have reported to be surprised of how strongly their lack of emotional expressions affected the infant (Brazelton & Cramer, 1990). Field (1984) has suggested that the Still Face interruption is an anxiety provoking situation for the caregivers as much as for the infants.

From DV studies, only Murray and Trevarthen (1986) and Stormark and Braarud (2004) have examined mothers' responses to the subtle manipulation of contingency in a DV set-up. Murray and Trevarthen (1986) found that both the content and the stylistic features which identify Infant Directed (ID) speech, changed from the live real time interaction to the replay recording of the infant, in a Live-Replay-Live-Replay set-up. In the replay sequences, the mothers' vocalisation was characterised as "mother directed" or "other directed", with more frequent negative statements and declaratives and shorter utterances. Stormark and Braarud (2004) did not find support for this when they observed and compared mothers' gaze foci in live interaction with mothers' gaze foci in replay interaction, during face-to-face communication with 2- 4 months old infants. The mothers looked at their infant nearly 100% of the time during all five sequences, and the only difference in amount of gaze was that the mothers looked significantly more at their infants in the last live sequence than in the preceding replay sequence. Stormark and Braarud's (2004) findings should, however, be interpreted with caution. Even if gaze matching between mothers and infants can be intersubjective in its nature, the mothers' prolonged gaze focus at their infants during the non-contingent replay sequence could as well be a natural response to the absence of proximity, reflecting mothers' attempt to re-orient the infants' attention. So, probably, sustained maternal gaze expresses different motives and depending on the context, and may not be a dynamic and valid variable in the testing of research questions addressing maternal responses to interrupted social contingency.

Murray and Trevarthen (1985) examined differences in content and stylistic features of the mothers' vocalisation during live- compared to replay sequences. Less is known about the effects of experimental manipulation of the prosodic organisation of ID speech. ID speech is also called motherese, and differs from adult directed speech in features such as higher pitch, slower speed and exaggerated intonation (Fernald & Simon, 1984). It is suggested that ID speech plays an important role in regulating infants' arousal and attention, and in infants' interpretation of caregivers' emotional signal (Panneton Cooper, Abraham, Berman & Staska, 1997). While semantic and syntactic features of parents' speech is relatively stable during infancy (Snow, 1977), the prosodic features vary in correspondence with the immediate affective state of the infant, the quality of the feedback from the infant, and the developmental changes during infancy (Fernald & Simon, 1984; Stern, Spieker, Barnett & MacKain, 1983).

1.2.4. Infant and caregiver responses during acute stress

Earlier, young infants were supposed to be insensitive to pain (Craig & Grunau, 1991), due to incomplete myelination of the nerve system (Bragado & Marcos, 1997; Ross & Ross, 1988). Pain research is complicated, since pain is subjectively felt and not directly accessible to the observer (Bragado & Marcos, 1997; Bush & Harkins, 1991). Therefore, researchers have had to rely on distress vocalisation, affective expressions, and fluctuations of stress hormones such as cortisol.

In several studies, Tronick and colleagues (Gianino & Tronick, 1988; Tronick, 2003; Weinberg & Tronick, 1994) have demonstrated an expressive flexibility which allows infants to adapt their behaviour and affect to different contexts. This is not necessarily evident in infants' facial expressions alone, but should rather be viewed as coherence over modalities which are specified to events (Weinberg & Tronick, 1994). Affective displays of negative evaluation of the ongoing interaction *can* be expressed with cry, gestures and other negative expressions, and the same variation can be seen regarding positive affect (see Tronick, 2003). It is also suggested that pain responses are highly sensitive to socialisation and psychosocial development (Bush & Harkins, 1991), as well as to the general pattern of infant-parent interaction (Sweet, McGrath & Symons, 1999).

A few studies have examined the influence of caregivers' soothing behaviour on alleviating infants' distress responses during acute pain. Lewis and Ramsay (1999) did not find any alleviating effects of maternal soothing on the infants' behavioural- and

cortisol responses during inoculation at 2 and 6 months of age. However, the potential influence of caregivers' behaviour on infants' distress responses is probably active in the period before the painful event as well. The few studies which have examined impacts of caregivers' behaviour before a painful situation on infants' post-pain behaviour, have found pain behaviour to be predicted by intra-individual levels of reactivity, parenting context such as degree of sensitivity (Sweet, McGrath and Symons, 1999), as well as the broader home cultural ecology (Axia & Weisner, 2002). Illustrative to the latter, Cook and Mineka (1987; 1990) found that rhesus monkeys acquired fear of snakes through observational learning of their parents' fear of snakes.

In older children, caregivers' influence on stress responses in painful situations has been examined in studies covering a range of procedures (Blount, Davis, Powers & Roberts, 1991). Experimental procedures have been to include or exclude parents from the treatment room, to interview children about parents' behaviour, or to learn parents or children in various coping strategies (Cohen, Blount, Cohen, Schaen & Zaff, 1999). Studies have confirmed that children's coping is related to parental behaviour (Bush, Melamed, Sheras & Greenbaum, 1986) alone or in combination with staff behaviour (Frank, Blount, Smith, Manimala & Martin (1995), while children's distress behaviour is influenced by parents' behaviour and earlier medical experiences (Frank et al., 1995). However, attempts to assess impacts of parental anxiety during their children's medical assessment have produced inconsistent results. While Frank et al. (1995) did not reported anxiety to predict parent in-session behaviour, Bush et al. (1986) found a significant relation between parents' high reported anxiety and their ignoring of the child during the medical session. There was, however, no relation between parents' reported anxiety and observed child behaviour. When assessing effects of interventions, it has been found that interventions prior to and during inoculation increase children's coping (Kolk, van Hoof & Fiedeldij Dop, 2000). A comparison between different intervention programs finds distraction to be more effective than local anesthetics and typical care (Cohen et al., 1999).

1.2.5. A synthesis: Co-creating a relational history and its implications on caregivers' and infants' coping in distressing situations; A transactional model

The introduction of the thesis presents the development of a relational history between the infant and his/her caregiver, which in turn affects their interaction during distressing events. It is acknowledged that early affective transactions between infant and caregiver

form an enduring attachment relationship (Bowlby, 1988). However, while attachment theory to a large extent emphasises the quality and quantity of experiences provided by the caregiver-environment (see Ainsworth, 1991; Weinfield et al., 1999), other theories emphasise resources offered by the infant. Temperamental factors, such as intra-individual differences in infants' reactivity pattern and regulation capacity (Rothbart and Derryberry, 1981), as well as the social nature of young infants (see Bateson, 1979; Trevarthen, 1979; 1980) will affect the caregiver and the relationship.

The social nature of infants during early interaction and transactions with the social environment has been described in Trevarthen's theory of intersubjectivity. The theory presents a view of the infant as born with social skills, motivated for social company, competent in being receptive to others' mental states, as well as competent in attuning its own internal state for emotional sharing with others. These capacities make the infant a sophisticated social partner who functionally adapts, actively seeks stimulation and regulates his/her behaviour through interaction with the environment (Zeanah et al., 1997). It is the specific microsystem of person-to-person communication which fosters the basis for the infant's emotional tie to the caregiver (Siegel, 2001; Trevarthen, 1979), and it is in this relationship the relational history develops (see Legerstee & Varghese, 2001). The social and emotional quality of the interaction between the caregiver and the infant is suggested to influence neural circuits responsible for social, emotional and cognitive functioning, and in turn, representations of repeated socio-emotional events will form an implicit memory of the relationship (see Siegel, 1999).

The dynamic reciprocal processes of continuous interaction between an infant and the experiences that is provided by the caregiver and social context, can be understood as transactional processes across time (see Sameroff, 2004), as illustrated in Figure 1. The developmental outcome of the infant can not be described without analysing impacts of environmental factors (Sameroff & MacKenzie, 2003b). Nevertheless, both environmental experiences available for the infant, and individual differences in what the infant elicits from the environment, are equally important components of the model. In this model, genetic and environmental regulators transact continuously and mutually (Zeanah et al., 1997). Environmental experiences are provided by the caregiver, the family and the social and cultural context, and are more continuous than random. It is important to note that experiences provided by the environment are also regarded as nonshared environmental influences unique to each child (Zeanah et al., 1997). Thus, the

developmental outcome of a child is a product of continuous and dynamic interaction between the environment and the child.

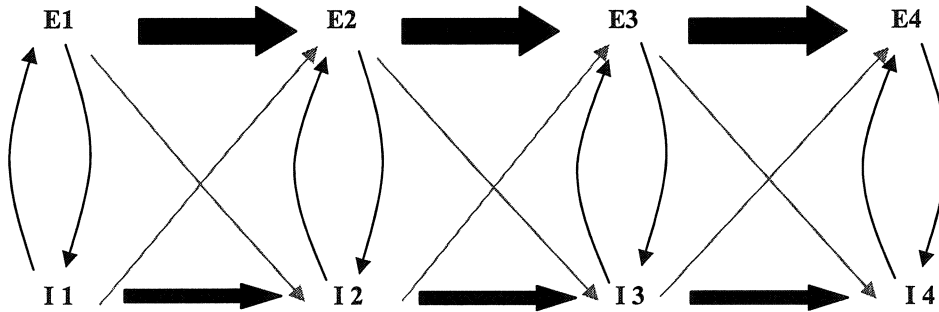


Figure 1.

Schematic outline of transactional processes between environment, such as the caregiver (E) and the infant (I). Within the transactional model, experiences provided by the caregiver is not independent of the infant (I), because the infant has been a strong determinant for their earlier experiences.

In early infancy, there is an asymmetry between other- and self-regulation, and the infant's physical and psychological growth and wellbeing depends on nutrition, warmth and love provided by the parent (Sameroff, 2004). However, even if this asymmetry exists, temperamental characteristics of the infant and the infant's social nature, influences the caregiver's behaviour as well. Transactional processes which take place will necessarily develop into a relational history which affects the infant and the caregiver's present behaviour, and which forms expectations to the partner's behaviour in future situations, including distressing ones. It is therefore hypothesised that infants' coping with distress can not be viewed as independent from the infants' relational experiences with the caregiving environment.

1.3. The scope and aim of the thesis

1.3.1. A presentation of the longitudinal project

The thesis portrays 50 mothers and their infants in a prospective longitudinal project, including five different experiments and situations assessing different levels of distress. The data collection took place in a period when the infants were from 2 to 17 months of age. Detailed observations and assessments of the infants and the mothers' social behaviour and emotional responses have been analysed separately, both in relation to

interpersonal distress and in relation to distressing events. The first study (study 1) examined infants' sensitivity to social contingency and mothers' prosodic modification and vocal production during subtle manipulation of contingency, in a DV laboratory (Paper I and Paper II). The next study (study 2) was a visual marking experiment where infants' selective attention skills were observed in an Inhibition of Return set-up (included in Paper III). Both studies took place when the infants' were approximately 2 months old. When the infants reached 3 months of age, a natural observation study (study 3) took place at the health care centre when the infants received inoculation against diphtheria, pertussis and tetanus (DPT) and Haemophilus influenza type b (HiB). The relation between maternal soothing behaviour, infants cry vocalisation, and adrenocortical activity was assessed (Paper III). A follow up study (study 4) of inoculation at the health care centre took place when the infants were 15 months old and received a combined inoculation against measles, mumps and rubella (MMR). The last study (study 5) was a Novel Situation experiment (see Waters, Wippman & Sroufe, 1979) which is a short version of the Strange Situation, and the study took place when the infants were 17 months old. Three separate papers have been written from the first three studies of the longitudinal project. See Table 1 for an overview of the five studies, the three papers and the sample.

Table 1.
Descriptive data of the studies and the sample

Study	Paper	Number of participants	Mean age (range)
1. Double-Video ¹	I	45	2 months, 13 days (6-17 weeks)
1. Double-Video ²	II	32	29 years (20-39 years)
2. Inhibition of Return ¹	III	44	2 months, 14 days (6-17 weeks)
3. Inoculation at 3 month ¹	III	37	13 weeks, 4 days (12-17 weeks)
3. Inoculation at 3 month ²	III	37	29 years (19-39 years)
4. Inoculation at 15 month ¹		30	15 months, 13 days (14-20 months)
5. Novel Situation ¹		30	17 months, 13 days (15-20 months)

¹ *Descriptive data of the infants*

² *Descriptive data of the mothers*

1.3.2 Research questions

In a first step, the thesis addressed factors related to the social and emotional capacity in young infants, which are suggested to be important for co-creation of transactional

processes. In a next step, it was explored how these transactions can be understood in distressing situations. The longitudinal design allowed a final step which was to investigate how early interactive behaviour-patterns associated with the mothers' and infants' behaviour influenced the infants' distress responses during distressing events later in the development.

Question 1: Are individual differences in infants' sensitivity to social contingency in the DV set-up related to differences in expressions of negative affect? (Paper I)

Question 2: Is infants' behaviour during face-to-face communication a real contributor to the dialog? If so; Does mothers' amount of Infant Directed speech increase during sequences of contingent- relative to non-contingent interaction? (Paper II)

Question 3: Can the relation between behavioural-, attentional- and physiological factors in mothers and their infants during acute stress be understood in terms of transactional processes? (Paper III)

Question 4: Does the mothers' level of discrimination of contingency and the infants' regulatory capacity have an impact on distress responses later on? (Analyses of longitudinal data from all papers and additional data from study 4 & 5)

2. PAPERS

2.1. Longitudinal sample

Fifty mothers and infants comprised the sample of this project. The recruiting was done in collaboration with nurses at six health care centres in the municipality of Bergen and in a nearby suburb. The nurses distributed requests for participation and an informed consent (see Appendix I) at home calls or wellbaby-visits at the health care centre. The mother, who agree to take part, mailed the informed consent in a pre-stamped envelope addressed to the researcher. Some weeks before the infants reached 2 months of age, the researcher contacted the mothers to make an appointment for the first experiment. The exclusion criteria for participating in the project were prenatal, antenatal or postnatal problems.

2.2. Methods

The thesis is built on data from the longitudinal project, where behavioural and physiological data are presented from the same cohort of mothers and infants in different studies, from when the infants were 2 to 17 months old. Longitudinal data have several

advantages; they highlight differences and changes over time, and can identify antecedents of phenomena (for instance social, emotional, and cognitive) which consequences can be outlined (see Ruspini, 2002). Thus, to explore factors hypothesised to influence the development of emotional regulation, the longitudinal design allows an examination of different factors' impacts on the development of emotional reactions (see Wagner, Kutash, Duchnowski & Epstein, 2005). In the project, the different experiments and observation studies reflect, in general, socio-emotional factors and mechanisms in caregivers and infants as well as in the relation between them. Both socio-emotional and temperamental domains are studied to address questions about transactional processes and the co-creation of a relational history.

2.3. Reliability

Interrater agreement was calculated for video recordings of both experimental and naturalistic observations. The reliability outcome was duration/sequence based, and gave a detailed indicator of correspondence between the observers. The tolerance window for accurate timing when comparing the two observers was one second in paper I, II, III and study 4, and five seconds in study 5. A main coder coded all the video-files, while a second coder coded 20 % of randomly chosen sets of video-files, except for paper III, where the second coder coded 87 % of the video-files. See Table 3 for an overview of interrater agreement for the dependent variables.

Salivary measures of cortisol assess the biological/physiological active fraction of the hormone in circulation. In general, studies have shown that salivary flow does not influence the cortisol concentration, and that the time course of salivary cortisol parallels plasma cortisol (Kirshbaum & Hellhammer, 1989), even though this is not reported for infants in particular.

As mentioned in Paper III, the salivary cortisol samples were analysed in accordance with the RiA principle. All samples were analysed in the same batch to reduce the probability of variation among the batches, and the intra-assay coefficient of variation was between 1.8 % - 6.3 %, with a detection limit at 0.15 nmol/l. Note also that the collection of saliva samples did not involve artificial substances used to induce a more pleasant taste of the cotton roll or to increase the saliva production.

Table 3.

Overview of interrater agreement between main observer and second observer in the five studies.

Study	Interrater agreement
<i>Double Video:</i>	
Infant gaze foci	.96
Infant affect	.95
Mother gaze foci	.97
Amount of mother's vocal sound	1.00
<i>Inhibition of Return:</i>	
Infant gaze foci	.83
<i>Inoculation at 3 month:</i>	
Maternal soothing behaviour	.91
Infant crying	.99
<i>Inoculation at 15 month:</i>	
Infant crying	1.00
<i>Novel Situation:</i>	
Affect	.92
Physical contact	
Object	
Mother's approach-behaviour against her infant*	

**The behaviour elements in this study were analysed together, which then resulted in one interrater agreement score.*

2.4. Ethics

The research was conducted in accordance with APA ethical standards in the treatment of the study sample. The protocol for the study was recommended by the Regional Committee for Medical Research Ethics in western Norway (see Appendix II).

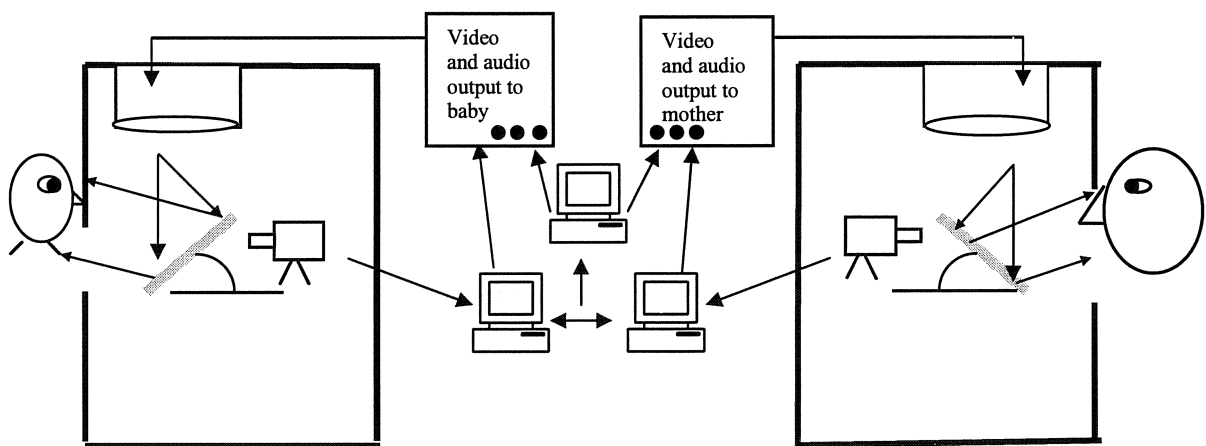
2.5. Presentation of papers and studies

2.5.1. Paper I: Expression of negative affect during face-to-face interaction: A double-video study of young infants' sensitivity to social contingency

The purpose of this study was to examine if young infants' sensitivity to social contingency is related to the degree of negative affect they express during the experiment. A more detailed analysis of negative affect was hypothesised to provide insight into what characterises infants who show sensitivity to social contingency compared to those who do not show this sensitivity, in a DV experiment.

The DV laboratory at the University in Bergen has an experimental set-up which includes five sequences, three live and two replay sequences in a Live1-Replay1-Live2-Replay2-Live3 order. Sequences of live face-to-face interactions were compared to sequences where the infant-mother interaction was set out of phase, by presenting either the infant or the mother a replay of their partner's behaviour from the first live interaction. In this way, the design makes it possible to control for the fatigue hypothesis, the familiarity effect and the carry over effect mentioned above (see Bigelow & Birch, 1999; Hains & Muir, 1996; Rochat et al., 1998).

Figure 2 shows the experimental set-up. The mother and the infant interacted through the closed-circuit TV-system where one could manually regulate whether the infant and the mother see and hear each other live or witness a replay from the first sequence (Live1).



Live 1	Infant sees partner live
Replay1	Infant sees a replay of partner's previous behaviour (Live1)
Live 2	Infant sees partner live
Replay 2	Infant sees partner live
Live 3	Infant sees partner live

Partner sees infant live
Partner sees infant live
Partner sees infant live
Partner sees a replay of infant's previous behaviour (Live1)
Partner sees infant live

Figure 2.

Schematic outline of the experimental set-up

During the experiment, the mother and the infant was seated inside a three sided booth, isolated with foam rubber to ensure optimal audio quality. Each partner observed a full size image which allowed them to have direct eye contact and to retain the voice of the partner.

The one-way mirrors were placed diagonally inside the booths, and both the mother and the infant were sitting approximately 50 cm from the mirror. The mirrors reflected the screen of 14 inch TV monitors that were placed on the top of each booth, facing the TV front down on the mirrors. Behind the one-way mirrors, the microphones were connected to a PC via an amplifier for the microphone, and the digital colour video cameras were connected to a Pinnacle Micro DC 30+ Videocard. The mother received the audio input from the infant through earplugs, to minimize the risk that TV speakers in the mother's booth would pick up her voice from the microphone in the infant's booth.

A local PC network, composed of three PCs equipped with the Microsoft Transaction Server software, transmitted the audio- and video signal from each partner to the other's TV-monitor and synchronised the transmission and recording of the signals in the different sequences of the experiment. All audio- and video signals from the mother and the infant were recorded on PC1 and PC2 and stored on separate files, during all five experimental sequences. Both PCs were equipped with Pinnacle System Miro version DC 30+ video-card. The files depicting the behaviour of the mother and the infant during the first interaction sequence (Live1) were copied from PC1 and PC2 to PC3, which was equipped with Pinnacle System Miro DC 10+ video-card to control the playback of the mother's and the infant's behaviour from the Live1 sequences during Replay1 and Replay2. This transmission of signals was controlled manually and occurred seamless, so that it appeared to be one long conversation sequence for both partners.

Socio-demographic questions were asked and filled out by a research assistant before the experiment.

The results showed a significant negative correlation between the infants' degree of negative affect and the average time of looking at the mothers during the three live sequences. A median split was calculated to separate the infants into a high-negative-affect group and a low-negative-affect group. The low negative affect infants looked significantly more at their mothers than at other foci during the live- but not the replay sequences, while the high negative affect infants did not differentiate. The results suggest that 2-4 months old infants are able to distinguish between experimental distortion of contingent aspects in live and replay sequences, but that the effect of the replay condition

may not be shown in moderate to high distressed infants. Our findings underline the importance of taking infants' emotional state into account in experiments intending to assess capacity for intersubjective communication.

2.5.2. Paper II: Prosodic modification and vocal adjustments in mothers' speech during face-to-face interaction with their 2- and 3- months old infants: A double video study

The study investigated prosodic aspects of Infant Directed (ID) speech and assessed the mothers' sensitivity to social contingency during face-to-face communication with their young infants in a DV experiment. The laboratory and experimental set-up follows that of Paper I. This is also a test of whether early face-to-face communication is mutually regulated, or if the two-way aspect of the communication simply reflects how the mothers adjust their behaviour to the infants' occasional behaviour and thus makes it look like mutual two-way interaction. If the case is that caregivers time their behaviour to pauses in the infants' occasional behaviour, the caregivers' would not detect any distortion of contingency, neither when they see a replay of their infant (this is Replay2 for the mothers; see Figure 2 above), nor when they see their infants' live responses to the replay of their own behaviour (which is Replay1 for the mothers).

Mothers' ID speech (mean fundamental frequency (F0), percentage amount of F0 speech and number of vocal sound) to their 2- 4 months-old during face-to-face interaction was assessed in the DV experiment presented in Paper I. ID speech is elsewhere found to depend on feedback from the infant to elicit and shape its full range of prosodic modification (Fernald & Simon, 1984). It was therefore hypothesised that if infants are active contributors to the interaction, the mothers would modify the prosody and amount of vocal sounds in their speech as a function of the quality of the infants' responses during contingent (live) and non-contingent (replay) interactions. However, if early mother-infant communication is merely a function of sensitivity of the mothers to respond in pauses between infants' occasional behaviour, it would not make a difference whether the mothers received contingent or non-contingent responses.

Note that the mothers were not told about the manipulation of contingency. They were only told that the purpose of the experiment was to study young infants' sensitivity to social interaction. All mothers were asked about their experience of the interaction after the experiment. None of the mothers had noticed that they had received a replay of their infant's previous behaviour during the experiment.

Amount of ID speech in the mothers' vocalisation during live interaction were compared to amount of ID speech in vocalisation in sequences where either the mothers (Replay2) or the infants (Replay1) were presented a replay of their partner's former behaviour.

The mothers evidenced a significant overall higher amount of ID speech during live- compared to replay sequences. There was also significantly more of ID speech during Live1 compared to both Replay1 and Replay2. However, there was a significant rise of ID speech from Replay2 to the following Live3 sequence, but not from the Replay1 to the following Live2 sequence. No differences in ID speech were found between the two replay sequences.

2.5.3. Paper III: Maternal soothing and infant stress responses: Soothing, crying and adrenocortical activity during inoculation

The relation between maternal soothing and infant stress responses during inoculation was examined in the same sample when the infants had reached 3 months of age. Instead of just investigating potential alleviating effects of maternal soothing on infant distress responses after the syringe injection, the observation period also included assessment of mothers' behaviour just prior to the aversive event. The mothers' soothing pre- and post-injection, the infants' cry vocalisations post-injection, and the mothers' and infants' salivary cortisol level pre- and post-injection, were analysed. In addition to the collection of behavioural and cortisol data at this time point, data from a visual marking task (Inhibition of Return study) was included in order to assess individual differences of the infants' attentional control of stimuli.

The mothers and infants completed the visual marking task in a laboratory when the infants were approximately 10 weeks old. The experimental laboratory included three adjacent PC monitors, with a digital video camera placed on top of the central monitor. The infant was seated about 90 cm in front of the monitors, with the two lateral monitors in a 30 degree angle from the infant. The digital video camera recorded the infant's gaze behaviour during the experiment. A mirror was placed behind the infant's chair so that the videotape also included the stimulus presentation on the PC monitors. This was to ensure that the coders could see what the infant was looking at.

Pictures depicting faces and geometrical figures served as both cue and target stimuli, while a blinking display of bright coloured circles served as the fixation stimulus. The stimuli were presented on the three adjacent PC-monitors, where the fixation

stimulus was always presented on the central monitor while the cue and target stimuli were presented on the left and right monitors. Each trial consisted of four events; First, the fixation stimulus was presented for 2500 milliseconds (ms) on the central monitor. Then the cue stimulus was presented for 2500 ms either on the left or the right monitor, followed by the fixation stimulus on the central monitor for 1000 ms. Finally, the target was presented for 5000 ms on both monitors. The content of the cue and the target either shared or did not share spatial location.

The inoculation took place at the local health care centre. The researcher met the mother, infant and nurse for saliva sampling and video recording of the inoculation. After the sampling of pre-injection saliva from the mother and the infant, the infant was undressed for inoculation. The time lag between these two events varied. All inoculations took place at the nurse's office. The Norwegian inoculation procedure for 3-months-olds involves injection of serum in the infant's thigh. The infant received the injection while lying or sitting on the caregiver's lap.

A non-intrusive video-recording of mother-infant interaction during inoculation was used to gather data about maternal soothing behaviour and infant distress responses related to a realistic and natural distressing event. The video-recording of the inoculation was done with a small digital video camera approximately 1.5 meter away from the nurse, mother and infant. The nurses had been told that they should carry out the procedure as usual, and the mothers were told to relate to their infants as they felt was right. The video-recording started approximately 1 minute before the injection of the needle, and ended when the infant had stopped crying. Then the experimenter left the nurse's office and waited outside for the post-inoculation saliva sampling.

The results showed a positive relation between infants cry vocalisation post-injection and maternal soothing pre- and post-injection. Interestingly, more than half of the mothers evidenced more soothing pre- compared to post -injection. Therefore, the sample was divided in two sub-groups depending on whether the mothers evidenced more soothing before (Preparatory group; n=20) or after (Contingent group; n=17) the syringe injection. In the Preparatory group, the duration of infants' cry vocalisation was related to the amount of maternal soothing before and after the injection, while cry vocalisation in the Contingent group was related to the amount of maternal soothing after the injection. The Contingent infants responded to the injection with a significant increase in cortisol response, while there was no such response in the Preparatory infants. There were no significant main effects or group differences concerning mothers' cortisol

levels. Nevertheless, the Preparatory infants evidenced significantly longer duration of looking at the target stimuli in the visual marking task, which, suggests that they had greater difficulties in disengaging attention. Rather than suggesting an alleviating effect of maternal soothing on infants' distress after painful stimulation, the findings indicate that 3-months-olds' stress responses and their mothers' situational behaviour during inoculation are mutually regulated.

2.5.4. Additional report from study 4 and study 5

In study 4, the procedure and the data collection resembled that of paper III, but the inoculation procedure for 15-month-olds involves injection of the serum in the infants' upper arm instead of the thigh. From a developmental perspective, inoculation at 3 months and inoculation at 15 months must be considered as two different contexts due to developmental changes in the infant and, accordingly, changes in the interaction between the mother and the infant. While the infants were held and carried by the caregiver most of the time during the 3 month inoculation, most of the infants had learned to walk at the time of the 15 month inoculation. Because of these developmental changes, many infants showed more resistance to the saliva sampling, and protested when they had to end their ongoing activity to be held by their mothers and prepared for injection of the serum.

Study 5, the Novel Situation study, is an experimental setting which was developed by Waters et al. (1979) as a short version of the Strange Situation where the quality of attachment between the infant and the caregiver is assessed (see Ainsworth, Blehar, Waters & Wall, 1978, for more details). The theory behind the Strange Situation experiment says that attachment between the parent and the child corresponds with the way the infant uses the parent as a secure base (Ainsworth et al., 1978). The Strange Situation and the Novel Situation both represents contexts where attachment behaviour is activated by the novelty of the situation, by the introduction of a stranger and by separation from the mother. The infant's attachment behaviour is hypothesised to be highly activated during separation, and thus, the reunion phases in Strange Situation research are considered as crucial in the assessment of the quality of attachment (Ainsworth et al., 1978). Other differences between the two studies are related to design and numbers of separations. There is only one toy in the Novel Situation and only one short separation phase.

The Novel Situation experiment took place in a room which was simply furnished with a sofa and two chairs, and a small table placed against the wall. The only toy, a large

green coloured ball decorated with butterfly pictures, was placed on the floor in the middle of the room. An observation room connected to the experimental room was equipped with two one-way windows. Audio output came from speakers in the observation room that was connected to a mix-board which received all audio input from a microphone in the ceiling of the experiment room. The Novel Situation consisted of four phases (see Table 2 below). The mothers were told not to initiate or get involved in any play with the infant, only to respond to the infants' initiatives. The mothers were allowed to end the experiment at any time in case they felt that the infant became too distressed.

Table 2.

Description of The Novel Situation study

Phase	Who is present	Duration	Description
1	Mother and infant	5-10 min.	The researcher presents the room for the mother and the infant. The mother is passive while the infant can play with the toy or explore in the room.
2	Mother, infant and stranger	3 min.	A stranger enters the room. After approximately 1 minute, she directs her attention to the infant and invites the infant to play with her. The phase ends when the mother leaves the room.
3	Infant and stranger	1 min.	The stranger and the infant interact.
4	Mother and infant	Open	Reunion between the mother and the infant. The stranger leaves the room.

In phase 1, the infant and the mother were alone in the room. The phase lasted from minimum 5 to maximum 10 minutes, depending on how long the infant needed to habituate to the situation. When the infant had started to play with the ball or to explore the room, the behaviour was interpreted as exploration behaviour and the phase ended as the strange woman entered the room. In phase 2, the mother should remain passive while the stranger invited the infant to play with the ball after approximately 1 minute. After 3 minutes, the researcher opened the door to the experiment room and gave the mother a signal to leave. The mother was instructed to announce her leaving by saying "good bye" to the infant and then leave. Then phase 3 started, in which the infant was alone with the

stranger for 1 minute. In the last phase (phase 4), the mother entered the room for reunion with the infant, while the stranger left the room.

The video recording of the participants' behaviour took place in the observation room next to the experimental room, through the two one-way windows. The video camera was placed on a tripod. The video recording started while the researcher introduced the experimental room to the mother and the infant.

The main intention of the longitudinal analysis was to evaluate the impacts of early mother and infant behavioural characteristics on infants' responses to distress later in infancy. Thus, a collection of behavioural data from all five studies was used for longitudinal analysis, but to make the measures fit the longitudinal research questions the thesis addresses, some of the behavioural data had to be analysed differently than in their respective papers.

Caregivers' sensitivity is associated with the development of the infants' attachment, and is considered to be important for development of self-regulation skills (Lyons-Ruth & Zeanah, 1993). To calculate a reflection of maternal sensitivity, data from the mothers' behaviour in the DV experiment was used, since the DV experiment gives insight into how mothers interact during face-to-face communication, and how they adjust their responses and show sensitivity to the quality of their infant's responses. The mean F0 measure of the mothers' vocalisation in the replay sequences was subtracted from the mean F0 in the live sequences, and constituted a measure of the mothers' prosodic discrimination.

Infants' contribution to the creation of a relational history with their caregivers has been suggested to involve both their temperament and their capacity for seeking social companionship. Temperament has been defined as individual differences in reactivity and self-regulation, involving neural attentional mechanisms which control emotional responses to distress and negative affect (see Posner & Rothbart, 1998; Rothbart & Derryberry, 1981; Rothbart, Posner & Rosicky, 1994). Data from the infants' visual selective attention in the IoR study was used as a measure of reactivity pattern and regulation capacity. A differential measure of the relative latency to shift from cued to novel target for each of the eight trials was calculated. Dependent variables were the infants' amount of crying after injection of the needle during 3 month and 15 month inoculation, and the amount of crying in response to maternal separation at 17 month.

To explore the relative influence of maternal prosodic discrimination on the infants' distress responses later in infancy, the median of the F0 differential measure was

calculated and used to split the infants into sub-groups. One sub-group consisted of infants whose mothers evidenced high F0 during the live sequences compared to the replay sequences (infants of high discriminatory mothers). The other sub-group consisted of infants whose mothers evidenced smaller or opposite F0 differentiation between the live- and replay sequences (infants of low discriminatory mothers). Then, to explore the relative influence of the infants' regulation capacity on the infants' distress responses later in infancy, the median was used to split the sample into two sub-groups depending on whether the infants evidenced moderate to strong IoR effect (infants with IoR effect) or low IoR effect (infants without IoR effect) during the visual marking task at 2 months of age. The Shapiro-Wilk test for normality showed a normal distribution of the prosodic differentiation measure ($W = .98$, $p = .98$) and the IoR differential measure ($W = .99$, $p = .96$).

To assess possible differences between infants of high discriminatory mothers and infants of low discriminatory mothers in distress crying at 3-, 15-, and 17 months, a two-way ANOVA was conducted on Groups (Infants of high discriminatory mothers, Infants of low discriminatory mothers) X Time (3-, 15-, 17 months of age). To assess possible differences between infants who evidenced an IoR effect with those who evidenced low IoR effect in distress crying at 3-, 15-, and 17 months, a two-way ANOVA was conducted on Groups (Infants with IoR, Infants without IoR) X Time (3-, 15-, 17 months of age).

The results did not reveal any main effects of group ($F(2, 52) = 2.4$, $p = .09$) or time ($F(2, 52) = .32$, $p = .72$) when comparing the group of infants with high discriminatory mothers and the group of infants with low discriminatory mothers with regard to their amount of distress crying at 3-, 15-, and 17 months (see Figure 3). Planned comparison between the two groups of infants showed that infants of high discriminatory mothers had a higher amount of distress crying during 3 month inoculation ($F(1, 26) = .26$, $p = .64$) and smaller amount of distress crying at 15 months of age ($F(1, 26) = .015$, $p = .90$) compared to infants of low discriminatory mothers, but not significantly so. At 17 months of age, the difference between the groups were more pronounced, showing that infants of high discriminatory mothers had a near to significant smaller amount of distress crying than infants of low discriminatory mothers ($F(1, 26) = 3.52$, $p = .07$).

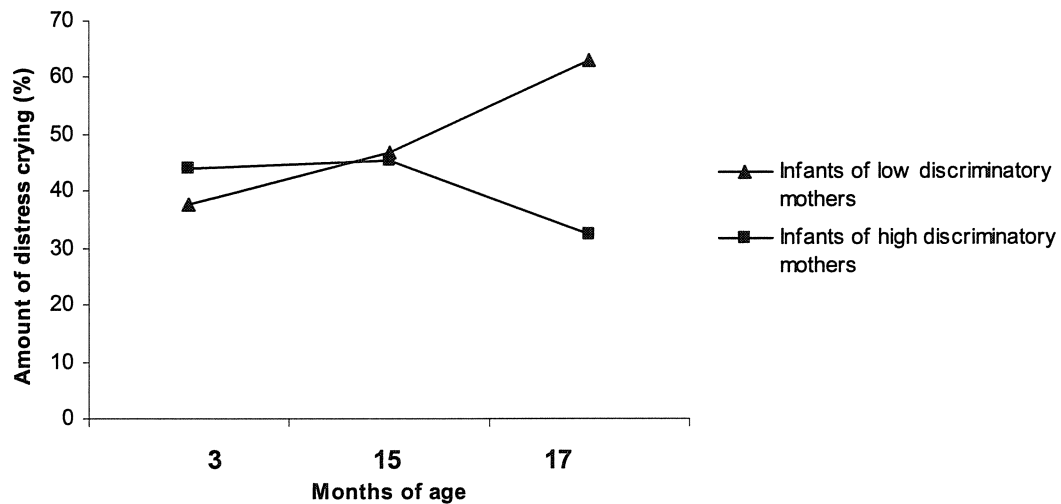


Figure 3.

Differences in distress crying at 3-, 15-, and 17 months between infants of low discriminatory mothers and infants of high discriminatory mothers. The sub-groups were dependent on whether the mother showed low or high prosodic discrimination during the DV experiment when the infants were 2 months old

When the infants were divided into sub-groups depending on their regulation capacity at 2 months of age, the comparison between infants with IoR effect and infants without IoR effect, did not show any main effect of groups ($F(2, 52) = 2.44, p = .09$) or time ($F(2, 56) = .54, p = .58$; see Figure 4).

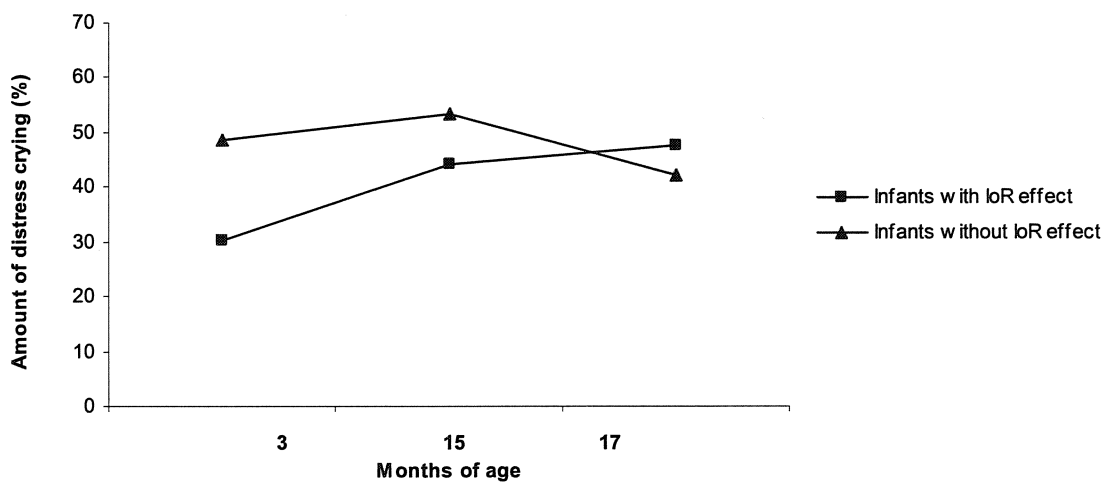


Figure 4.

Differences in distress crying at 3-, 15- and 17 months between infants who evidenced IoR effect and infants who did not evidence IoR at 2 months of age

Planned comparison between the two groups of infants did not show any significant effects. Infants who did not evidence an IoR effect had more distress crying than infants who evidenced an IoR effect at 3- ($F(1, 28)= 2.39, p= .13$) and 15- ($F(1, 28)= .67, p= .41$) month inoculation. Then, at 17 months of age, infants who evidenced an IoR effect showed slightly more distress crying than infants who did not evidence an IoR effect at 2 months of age ($F(1, 28) = .11, p= .74$).

Conclusively, the results from the first analyses did not evidence any differences between the two groups of infants concerning their distress responses to inoculation at 3 and 15 months of age. However, there was a tendency towards a statistical difference between the two groups of infants' distress responses at 17 months of age. In the second analyses, the infants were sub-grouped depending on whether they evidenced an IoR effect in the IoR study at 2 months of age or not. Even if the two groups showed different distress response patterns over time, the results did not show any significant group differences concerning distress responses at 3-, 15- and 17 months of age.

3. DISCUSSION

3.1. Summary of empirical findings

First, the results in Paper I showed variability in negative affect among the infants. Investigation of the impact of negative affect on capacity to be sensitive to and regulate behaviour in relation to contingent and non-contingent communication, showed a significant negative correlation between the infants' degree of negative affect and the average time of looking at the mothers during the three live sequences. The infants were then divided by a median split into separate groups named high- or low-negative-affect groups. While low-negative-affect infants showed sensitivity to social contingency, infants who expressed more negative affect did not show this sensitivity.

The result in Paper II revealed significant changes in the mothers' modification of their ID speech, with a significant decrease in ID speech during each replay sequence compared to the previous live sequence. Thus, when the quality of the contingency of infants' behaviour during the interaction was reduced, the mothers reacted with fewer vocalisations, lower mean F0, and less percentage of F0 in their speech. One could suspect that the mothers remembered the infants' behaviour from Live1, so that the reduction in ID speech during Replay2 was a memory effect rather than a reaction to the distortion of contingency in itself. However, a similar decline was found in Replay1

where the mothers saw their infant live. Nevertheless, in Replay1, the distortion of contingency was natural as the infants responded to a recording of their mothers' behaviour. Thus, the results suggest that mothers' ID speech is dependent upon the quality of infants' responsiveness and not just style of speech.

The results in Paper III showed a positive relation between infants' cry vocalisation post-injection and maternal soothing pre- and post-injection in the whole sample. However, 20 of 37 mothers soothed their infants more pre- than post- injection. This sub-group of mothers and infants was therefore referred to as the Preparatory group. The other 17 mothers evidenced more soothing after than before the injection, and the sub-group was referred to as Contingent mothers and infants. In the Preparatory group, the duration of the infants' cry vocalisation was related to the amount of maternal soothing before and after the injection, while cry vocalisation in the Contingent infants was related to the amount of maternal soothing after the injection only. The Contingent infants responded to the injection with a significant increase in cortisol level, while there was no such increase in the Preparatory infants. Results from the IoR study showed that the Preparatory infants looked significantly longer at the target stimuli in the visual marking task, which suggests that the Preparatory infants had more difficulties in disengaging attention.

The results from the longitudinal analysis showed that infants of high discriminatory mothers had a different, though not significant, distress response pattern at 3-, 15-, and 17 months compared to infants of low discriminatory mothers. When comparing distress responses at 3-, 15-, and 17 months between infants who evidenced an IoR effect and infants who did not evidenced an IoR effect at 2 months of age, the results showed different distress response patterns, but not significantly so.

3.2. Main discussion of the research questions

Double Video studies address questions about the pre-symbolic intelligence of young infants, and consequently about the dynamic mutual processes that take place between the infant and the environment according to the transactional model. Some earlier DV studies have found evidence for sensitivity to social contingency in infants (Murray & Trevarthen, 1985; Nadel et al., 1999; Stormark & Braarud, 2004), while other studies have failed to confirm it (Hains & Muir, 1996; Rochat et al., 1998). In Paper I, a more detailed assessment of infants' affective expressions and visual gaze showed an association between social sensitivity and negative affect: Infants who showed high

levels of negative affect did not show sensitivity to social contingency, while infants who were low in negative affect showed such sensitivity.

The results from Paper I are not surprising in them selves, but since the infants' gaze behaviour is analysed in conjunction with observations of their affective state, the results give better insight into coping with minor distress than earlier research has done (See Hains & Muir, 1996; Rochat et al., 1998). Thus, rather than thinking that some infants show sensitivity to social contingency while others do not, the results may be seen as a reflection of different levels of experienced distress and different coping strategies during distortion of contingency in face-to-face communication. As an illustration, if one considers expressions of affective experiences along a continuum from positive- to negative affect, one might find expressions of happy smiles and laughter in one end, and excessive crying in the other end. Note that the infants who cried in the study were not included in the statistical analyses, suggesting that the high-negative-affect group of infants was not in the negative end of this continuum. An interpretation could be that the results reflect individual differences in experienced level of interpersonal distress, and how the infants cope with this distress. This interpretation addresses the infants' capacity of an expressive flexibility over modalities which allow infants to regulate their behaviour and cope with different states of distress (see Gianino & Tronick, 1988; Tronick, 2003; Weinberg & Tronick, 1994). This perspective then underlines what has been put forward in the theory of intersubjectivity, where infants' motives are believed to structure states and specify actions in correspondence with the context (Trevarthen, 2001). Accordingly, the interpretation supports the transactional model, which holds the view that infants are actively involved in transactions with the environment, but that there is an asymmetry between self- and other-regulation which becomes more balanced as the child develops (Sameroff, 2004).

Further testing of the social nature of young infants stems originally from a controversy about the reciprocal nature of early face-to-face communication, and about whether infants really contribute actively to the dialogue or not. Testing of infants' sensitivity to social contingency has supported Bateson's report (1979) from naturalistic studies of "protoconversation" which took place during infant-caregiver interaction. Support for infants' capacity to detect changes from non-contingent to contingent interaction, and then react with a restitution of their non-verbal communication, has been presented in Paper I, and has earlier been demonstrated by Nadel et al. (1999) and Stormark and Braarud (2004). Another way of exploring if infants actively contribute to

the dialog would therefore be to examine mothers' communication behaviour during face-to-face communication with their infants.

The results in Paper II suggest that mothers modify their ID vocalisation in accordance with the immediate quality of the interaction, and attune to the infants' unresponsiveness. Thus, the results do not verify the hypothesis that the appearance of social-like responsiveness on the part of the infant is not more than effective and sensitive communication because the caregiver times and attune their responses to the infant's occasional behaviour. Note that this experiment contains short sequences of 30 seconds, and it can be difficult to tell whether the mothers imitated the infants' internal state, or imitated and attuned to the quality of the infants' responsiveness. A suggestion would be that the decrease in the mothers' ID speech during the replay sequences matched the lack of contingency, while the increase in the mothers' ID speech in the live sequences functioned to both elicit, match and maintain the communication (see also Panneton Cooper & Aslin, 1990). The results confirm that caregivers' behaviour during interaction depends on feedback from their infants and on the quality of the interaction that took place. Not only did the mothers respond significantly to an unexpected ending of the interaction, but they also matched their ID speech dynamically to different kinds of manipulations of contingency, or in other words, to the quality of the infants' contribution to the interaction.

The results in Paper III indicate that there is a non-linear relation between maternal soothing behaviour and infant distress responses during stressful situation such as inoculation. Retrospective data of the infants' attentional control assessed one month earlier complements the picture, showing a significant difference in attentional control between the Preparatory infants and the Contingent infants. The results from Paper III suggest that both biological- and context-dependent maternal and infant responses to distressing events are mutually regulated. And even if maternal soothing is considered to alleviate infants who are in distress, contextual factors and transactional processes need to be considered.

A possible interpretation might be that the mothers were not only influenced by the infants' distress, but also by expectations of the distress associated with witnessing the inoculation. Such expectations could be caused by several factors, both related to the caregivers' experiences independent of the relational history with the infant, but also to earlier experiences with the infant. The infants, on the other side, respond with crying to the aversive event, but can also, as evident in the relation between pre-injection soothing

and post-injection cry vocalisation, be influenced by the context prior to the syringe injection. Lack of a significant elevation of cortisol level among the Preparatory infants might be due to their mothers' pre-injection soothing, which in turn had an alleviating effect on the infants' cortisol level post-injection. However, if the Preparatory mothers' pre-injection soothing reflected anxiety for the forthcoming event, an alternative explanation would be that the pre-injection level of cortisol was already elevated in the Preparatory infants and thus constrained the post-injection level (see also Gunnar & Prudhomme White, 2001).

Due to the transactional processes, the infant has contributed to the dynamic processes with the mother from birth. These contributions are not only related to self-regulation capacity and reactivity pattern during distress, but to the whole appearance of skills and/or difficulties which influence the caregiver's practices and representations of the infant. The representations guide the caregiver practices, affect the representations and give meaning when they are translated into the storied representation (see also Sameroff, 2004). The transactional model is found useful in structuring the description of the development of a relational history, and accordingly gives a more complex understanding of the dialectic nature of the relation between caregiver soothing and infant distress responses during acute pain. It is first and foremost a theoretical perspective which has been used in the thesis to describe the development of a relational history between the infant and the caregiver, which argues for a complex understanding of the dialectic processes that take part between the infant and the social environment.

The thesis is based on a longitudinal project where mothers and infants have been observed in different distressing situations and contexts which subsequently involve emotional regulation. In an attempt to test the transactional model empirically, the thesis has specified a developmental model of emotional regulation that proposes that infants and small children need external support to regulate emotions (see Kopp, 1989; Sameroff, 2004), and that the development of more cognitive-related regulation is dependent on early social-emotional processes between the infant and the caregiver (see Kopp, 1989). The attachment behaviour system, which regulates proximity between the infant and his/her attachment figure, are closely linked to sensitive caregiving and social-emotional processes. However, infants are endowed at birth with biological, emotional and social capacities which enable them to actively seek social stimulation and regulate their behaviour through interaction with their caregiver (see Trevarthen, 2001; Zeanah et al.

1997). One such capacity is associated to temperamental-related differences in reactivity and regulation (see Posner & Rothbart, 1998; Rothbart & Derryberry, 1981).

Longitudinal aspects of the infants' behaviour responses were first tested in Paper III. Data of the infants' attentional control at 2 months were included in the exploration of the relation between mothers' soothing behaviour and infants' distress responses when the infants were 3 months old. It was found that mothers' soothing behaviour just prior to- and after the injection of the needle, were related to the infants amount of attentional control at 2 months as well. Infants of the Preparatory mothers had significantly more difficulties with their attentional control one month earlier, than infants of mothers who soothed their infants contingently in relation to the injection.

Nevertheless, when prolonging the time interval of the longitudinal analysis to include the infants' distress crying at 3-, 15-, and 17 months of age, we could not find empirical evidence for longitudinal influences off mothers' prosodic discrimination and infants' regulation capacity. Note that the data of the infants' gaze behaviour during IoR were now calculated to reflect the Inhibition of Return effect, which is different from the attentional control measure used in Paper III.

The first analyses at this level investigated whether different degrees of the mothers' prosodic discrimination had an impact on the infants' distress response to injection of the needle during inoculation at 3 and 15 months of age, and the infants' distress response to separation from the mothers in a Novel Situation at 17 months of age. The results did not evidence any statistical difference between the groups at the different time points. However, there was a tendency towards a statistical difference in the amount of infants' distress response during the Novel Situation, where the infants of the low discriminatory mothers at 2 months cried longer than the infants of high discriminatory mothers. This tendency can be interpreted in terms of the nature of the situations the infants' distress response was observed in, and/or by the age of the infants. The Novel Situation is qualitatively different from the inoculation situation. This holds probably for both the infants and the mothers. The inoculation is per definition nocioceptive stimulation (Gunnar, 1992; Negayama, 1999; Sweet, McGrath & Symons, 1999), but can, as shown in Paper III, provoke variable soothing behaviour in the caregiver. The Novel Situation creates psychological stress by the strange woman who enters the room and then by separation from the mother, and provokes by this the attachment system in the infant. If maternal discrimination between contingent- and non-contingent interactions reflects maternal sensitivity, a tentative interpretation might be that early sensitive

caregiving promotes reciprocal emotional communication between the parent and the infant. Such repeated experiences of attachment transactions may become encoded in implicit memory as expectations of the attachment figure and a representational model of the attachment relationship, and foster infants' self-regulation skills (Lyons-Ruth & Zeanah, 1993). Thus, transactional processes could have set the "frame" for the development of the dyadic relational history. This interpretation would then correspond with the main hypothesis in the attachment theory. The tendency towards a difference in distress responses during Novel Situation could also possibly be a developmental effect. The mothers who were most sensitive towards their infants at 2 months, were more involved with the infants' regulation of distress at 3- and 15 months, and the infants showed a coping pattern during separation which was different from infants of less sensitive mothers. However, this interpretation is not necessarily alternative to the explanation that was presented first. It only suggests that the dyadic relational history becomes more stable in correspondence with transactional processes during development.

The second analysis investigated the impact of infants' regulation capacity on crying response to the same distressing events later in infancy. The results did not evidence any longitudinal effects of 2 months olds' IoR skill. The most expressed difference between the groups was related to the 3 month inoculation, where the infants who evidenced IoR effect at 2 months of age also showed less amount of distress crying, compared to the infants who evidenced low IoR effect at 2 months of age. However, this difference was reversed when the infants' reached 17 months: Infants who evidenced low IoR effect capacity at 2 months showed less amount of distress during the Novel Situation than the infants who evidenced IoR effect at 2 months. This could imply that there is stability, or some sort of a carry over effect in the infants' regulation capacity from 2 to 3 months of age, but that this stability disappears with further development. An alternative explanation would be that the infants' regulation capacity at 2 months does not have a predictive power for the infants' distress regulation later in development.

The transactional model of development is the most widely accepted model for developmental process (Zeanah et al., 1997). However, it is also acknowledged that the research field needs a more precise model to explain both risk- and protective factors in development. Recent research on the impact of risk factors on development suggests a dosage effect, where a total number of risk factors are more predictive for later functioning than specific exposure to one risk factor alone (see Sameroff, 2005; Zeanah et al. 1997). This may be true for the longitudinal analysis in the thesis as well. Even if it

is found that both caregivers' sensitivity and more biological based regulation mechanism in infants are important for how caregivers and infants form their relationship, there are other important factors as well. Thus, future research should explore for combination of multiple factors that are considered to be important in relation to the development of self-regulation skills.

3.2.1. Validity

Assessing and interpreting responses from non-verbal infants is challenging, and the observer has to integrate complex information. Concerning the issues of minor and major distress which are raised in the thesis, validity is taken care of through integration of vocal and non-vocal behaviour, physiological information, as well as information about the physical and social context in which the observations took place (see also Craig & Grunau, 1991).

Paper I consisted of systematic observations of a multimodal facet of affective behaviour; the infants' gaze foci, head and arm movements, and cry vocalisation. In paper II, different aspects of prosody in the mothers' ID speech (mean F0, the percentage amount of produced F0 vocalisation), and amount of vocal sound were chosen as dependent variables. The prosodic modification in caregivers' speech to young infants is thought to depend on feedback from the infant (see Fernald & Simon, 1984; Stern et al., 1983). When Stormark and Braarud (2004) first explored mothers' behaviour in a DV experiment, we assessed the mothers' amount of gaze at their infants, and found that the mothers looked at their infants nearly 100% of the time in all five sequences. Visual gaze at a person can, however, represent different content, derived from different motives. Caregivers can respond with an intense gaze at their infant during intimate intersubjective sharing, but also show the same amount of gaze in an attempt to receive attention. Thus, in order to explore the question with more qualified and dynamic measures, prosodic modification of the caregivers' ID vocalisation were assessed in Paper II. Paper III was more challenging, both because the study was a non-invasive natural observation of mother-infant interaction during a painful event, and because the interaction was physically intimate. Maternal soothing behaviour was based on the mothers' physical soothing and facial contact with her baby. The injection is defined by several researchers as nociceptive stimulation (Gunnar, 1992; Negayama, 1999; Sweet, McGrath & Symons, 1999), but even if infant crying is a highly salient signal of the infants' wellbeing, its specificity to subjective states is questionable (Craig & Grunau, 1991).

Since the mothers' behaviour during inoculation could have been affected by the forthcoming injection, both pre- and post-assessment of maternal soothing was done. And since psychological variables are known to regulate cortisol (see Gunnar & Prudhomme White, 2001), this argument also has relevance for the cortisol measures. Therefore, salivary cortisol, pre- and post-injection, for both the mothers and the infants was assessed in addition with the observational data.

In the analyses of longitudinal data, a maternal discriminatory score was constructed and the median of the F0 differential measure was used to split the infants into one sub-group with infants of high discriminatory mothers and another sub-group with infants of low discriminatory mothers. The labels of the sub-groups reflects calculation of the mothers' sensitivity to the distortion of contingency during interaction with their infants in the DV experiment, and is therefore not a measure of maternal sensitivity in general. The mothers known as less discriminatory could have high or low mean F0, but there was less variation of mean F0 between the live and the replay sequences compared to the high discriminatory mothers.

4. CONCLUSION

Conclusively, infants who expressed low degree of negative affect look more at their caregiver during contingent than non-contingent interaction. Infants who expressed high degree of negative affect did not show any difference in looking at their caregiver in contingent live sequences compared to non-contingent replay sequences during the DV experiment. A further examination of young infants' social contribution in face-to-face interaction with their caregiver was addressed in research question II. The mothers' prosodic modification and vocal production was found to vary along with the quality of contingency which was manipulated in the DV experiment. In a broader sense, the results from both Paper I and Paper II reflect transactional processes. There are reciprocal processes between the infant and the caregiver, and the behaviour provided by one person is not independent of the other. In Paper III a non-linear relation between maternal soothing and infant cry vocalisation was found in both the Contingent and the Preparatory group. Data of cortisol responses in the infants were found to correspond with maternal soothing behaviour. The results showed that caregivers' and infants'

behavioural and biological responses and context-dependent factors influenced their distress responses during acute pain.

The longitudinal results from Paper III showed that the mothers soothing behaviour during inoculation corresponded with the infants' level of attentional control a month earlier. Regarding effects of prosodic discrimination on the infants' distress response at 3-, 15- and 17 months, or of different Inhibition of Return capacity in the infants on their distress responses to the same events later on, no longitudinal effects were found. However, the results showed a tendency towards a difference in the infants' distress response at 17 months of age, where infants of low discriminatory mothers cried more than infants of high discriminatory mothers. Future research should explore combinations of multiple factors that are considered to be important in relation to the development of self-regulation skills.

5. REFERENCES

- Ainsworth, M. D. S. (1982). Attachment: Retrospect and Prospect. In C. M. Parkes & J. Stevenson-Hinde (Eds.), *The place of attachment in human behaviour* (pp. 3-30). New York: Basic Books.
- Ainsworth, M. D. S. (1991). Attachments and other affectional bonds across the life cycle. In C. M. Parkes, J. Stevenson-Hinde & P. Marris (Eds), *Attachment across the life cycle* (pp. 33-51). New York, US: Tavistock/Routledge.
- Ainsworth, M. D. S., Blehar, M. C., Waters, E., & Wall, S. (1978). *Patterns of Attachment. A psychological study of the strange situation*. Hillsdale, N.J.: Lawrence Erlbaum.
- Axia, G., Bonichini, S., & Benini, F. (1999). Attention and reaction to distress in infancy: A longitudinal study. *Developmental Psychology*, *35*, 500-504.
- Axia, V. D., & Weisner, T. S. (2002). Infant stress reactivity and home cultural ecology of Italian infants and families. *Infant Behavior & Development*, *25*, 255-268.
- Bateson, M. C. (1979). "The epigenesis of conversational interaction": a personal account of research development. In M. Bullowa (Ed.), *Before speech* (pp. 63-78). Cambridge: Cambridge University Press.
- Beebe, B. (2000). Coconstructing Mother-Infant Distress: The Microsynchrony of Maternal Impingement and Infant Avoidance in the Face-to-Face Encounter. *Psychoanalytic Inquiry*, *Vol. 20 (3)*, 421-440.
- Beebe, B., Knoblauch, S., Rustin, J., & Sorter, D. (2003). Introduction. A Systems View. *Psychoanalytic Dialogues*, *13(6)*, 743-775.
- Bigelow, A. E., & Birch, S. A. J. (1999). The effects of contingency in previous interactions on infants' preference for social partners. *Infant Behavior & Development*, *22*, 367-382.
- Bigelow, A. E., MacLean, B. K., & MacDonald, D. (1996). Infants' responses to live and replay interactions with self and mother. *Merrill-Palmer Quarterly*, *Vol. 42, No. 4*, 596-611.
- Bloom, L. (1993). *The transition from infancy to language: Acquiring the power of expression*. New York: Cambridge University Press.
- Blount, R. L., Davis, N., Powers, S. W., & Roberts, M. C. (1991). The influence of environmental factors and coping style on children's coping and distress. *Clinical Psychology Review*, *Vol. 11*, 93-116.

- Bowlby, J. (1951). Maternal care and mental health. *The Monograph Series of the World Health Organization (serial No. 2)*. Geneva: World Health Organization.
- Bowlby, J. (1969). *Attachment and Loss, Vol. 1: Attachment*. Middlesex, England: Penguin Books.
- Bowlby, J. (1973). *Attachment and Loss, Vol. 2: Separation*. Middlesex, England: Penguin Books.
- Bowlby, J. (1988). *A secure base*. New York: Basic Books.
- Bragado, C. Á., & Marcos, A. F. (1997). Psychological treatment of evoked pain and anxiety by invasive medical procedures in paediatric oncology. *Psychology in Spain, Vol. 1, No. 1*, 17-36.
- Brazelton, T. B. (1982). Joint regulation of neonate-parent behavior. In E. Z. Tronick (Ed.), *Social interchange in infancy* (pp. 7-22). Baltimore: University Park Press.
- Brazelton, T., & Cramer, B. G. (1990). *The Earliest Relationship*. USA: Addison-Wesley Publishing Company, Inc.
- Bretherton, I. (1992). The origins of Attachment Theory: John Bowlby and Mary Ainsworth. *Developmental Psychology, 28*, 759-775.
- Bullowa, M. (1979). Introduction: Prelinguistic communication: a field of scientific research. In M. Bullowa (Ed.), *Before speech* (pp.1-62). Cambridge: Cambridge University Press.
- Bush, J. P., & Harkins, S. W. (1991). Conceptual foundations: Pain and Child Development. In J. P. Bush & S. W. Harkins (Eds.), *Children in Pain. Clinical and Research Issues From a Developmental Perspective* (pp. 1-32). New York: Springer-Verlag.
- Bush, J.P., Melamed, B. G., Sheras, P. L., & Grennbaum, P. E. (1986). Mother-Child Patterns of Coping with Anticipatory Medical Stress. In B. G. Melamed, K. A. Matthews, D. K. Routh, B. Stabler & N. Schneiderman (Eds.) *Child Health Psychology*, 1988 (pp. 201- 213). New Jersey: Lawrence Erlbaum Associates.
- Carey, W. B. (1999). Acute Minor Illness. In M. D. Levine, W. B. Carey & A. C. Crocker (Eds.), *Developmental-Behavioral Pediatrics* (pp. 321-323). Philadelphia: W. B. Saunders Company.
- Cassidy, J. (1999). The nature of the child's ties. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of Attachment* (pp. 3-20). New York: The Guilford Press.
- Cohen, L. L., Blount, R. L., Cohen, R. J., Schaen, E. R., & Zaff, J. F. (1999). Comparative Study of Distraction Versus Topical Anesthesia for Pediatric pain

- Management During immunization. *Health Psychology, Vol. 18, No. 6*, 591-598.
- Cook, M., & Mineka, S. (1987). Second-order conditioning and overshadowing in the observational conditioning of fear in monkeys. *Behaviour Research and Therapy, 25*, 349-364.
- Cook, M., & Mineka, S. (1990). Selective Associations in the Observational Conditioning of Fear Rhesus Monkeys. *Journal of Experimental Psychology, Vol. 16, No. 4*, 372-389.
- Craig, K. D., & Grunau, R. V. E. (1991). Developmental Issues: Infants and Toddlers. In J. P. Bush & S. W. Harkins (Eds.), *Children in Pain* (pp. 171-194). New York: Springer-Verlag.
- Fernald, A. (1992). Human Maternal Vocalisation to Infants as Biologically Relevant Signals: An Evolutionary Perspective. In J. H. Barkow, L. Cosmides & J. Tooby (Eds.), *The Adapted Mind. Evolutionary Psychology and the Generation of Culture* (pp. 391-428). New York: Oxford University Press.
- Fernald, A., & Simon, T. (1984). Expanded Contours in Mothers' Speech to Newborns. *Developmental Psychology, Vol. 20, No.1*, 104-113.
- Field, T. (1984). Early interaction between infants and their postpartum depressed mothers. *Infant Behavior & Behavior, 7*, 517-522.
- Frank, N. C., Blount, R. L., Smith, A. J., Manimala, R. M., & Martin, J. K. (1995). Parent and Staff Behavior, Previous Child Medical Experiences and Maternal Anxiety as They Relate to Child Procedural Distress and Coping. *Journal of Pediatric Psychology, 20, (3)*, 277-289.
- Gallese, V. (2003). The Roots of Empathy: The Shared manifold Hypothesis and the Neural Basis of Intersubjectivity. *Psychopathology, 36*, 171-180.
- Gianino, A., & Tronick, E. Z. (1988). The Mutual Regulation Model: The Infant's Self and Interactive Regulation and Coping and Defensive Capacities. In T. M. Field, P. M. McCabe & N. Sneiderman (Eds.), *Stress and coping across development* (pp. 47-68). England: Lawrence Erlbaum Associates.
- Gillman, J. B., & Mullins, L. L. (1991). Paediatric pain Management: Professional and Pragmatic Issues. In J. P. Bush & S. W. Harkins (Eds.), *Children in Pain. Clinical and Research Issues from a Developmental perspective* (pp. 117-148). New York: Springer-Verlag.
- Gunnar, M. R. (1992). Reactivity of the hypothalamic-pituitary-adrenocortical system to stressors in normal infants and children. *Pediatrics, Vol. 90, Nr. 3*, 491-497.

- Gunnar, M., & Prudhomme White, R. B. (2001). Salivary cortisol measures in infants and child assessment. In L. T. Singer & P. S. Zeskind (Eds.), *Biobehavioral assessment of the infant* (pp. 167-189). New York: The Guilford Press.
- Hains, S. M., & Muir, D. M. (1996). Effects of Stimulus Contingency in Infant-Adult Interactions. *Infant Behavior & Development, 19*, 49-61.
- Heimann, M. (2002). Notes on individual differences and the assumed elusiveness of neonatal imitation. In A. N. Meltzoff & W. Prinz (Eds.), *The Imitative Mind. Development, Evolution, and Brain Bases* (pp. 74-84). Cambridge, UK: Cambridge University Press.
- Kirschbaum, C., & Hellhammer, D. H. (1989). Salivary Cortisol in Psychobiological Research: An Overview. *Neuropsychobiology, 22*, 150-169.
- Kokkinaki, T., & Kugiumutzakis, G. (2000). Basic aspects of vocal imitation in infant-parent interaction during the first 6 months. *Journal of Reproductive and Infant Psychology, Vol. 18, No. 3*, 173-186.
- Kolk, A. M., van Hoof, R., & Fiedeldij Dop, M. J. C. (2000). Preparing children for venepuncture. The effect of an integrated intervention on distress before and during venepuncture. *Child: Care, Health and Development, Vol. 26, Nr. 3*, 251-260.
- Kopp, C. B. (1989). Regulation of Distress and Negative Emotions: A Developmental View. *Developmental Psychology, Vol. 23, No. 3*, 343-354.
- Legerstee, M., & Varghese, J. (2001). The Role of Maternal Affect Mirroring on Social Expectancies in Three-Month-Old Infants. *Child Development, Vol. 72, Nr.5*, 1301-1313.
- Lewis, D. (1978). *The secret language of your child. How children talk before they can speak*. London: Souvenir Press.
- Lewis, M., & Ramsay, D. (1999). Effect of Maternal Soothing on Infant Stress Response. *Child Development, Vol. 70, Nr. 1*, 11-20.
- Lyons-Ruth, K., & Zeanah, C. H. (1993). The family context of infant mental health: Affective development in the primary caregiving relationship. In C. H. Zeanah, (Ed.), *Handbook of infant mental health* (pp. 14-37), New York: Guilford Press.
- Magai, C. (1999). Affect, Imagery, and Attachment. Working Models of Interpersonal Affect and the Socialization of Emotion. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of Attachment* (pp. 787-802). New York: The Guilford Press.
- Malpas, J. (2000). Between ourselves: Philosophical conceptions of intersubjectivity.

- International Journal of Psychoanalysis*, 81, 587-592.
- Murray, L. (1998). Contributions of experimental and clinical perturbations of mother-infant communication to the understanding of infant intersubjectivity. In S. Bråthen (Ed.), *Intersubjective Communication and Emotion in Early Ontogeny* (pp. 127-143). Cambridge: Cambridge University Press.
- Murray, L., & Trevarthen, C. (1985). Emotional Regulation of Interaction Between Two-month-olds and their Mothers. In T. M. Field & N. A. Fox (Eds.), *Social Perception in Infants* (pp. 177-198). New Jersey: Ablex Publishing Corporation.
- Murray, L., & Trevarthen, C. (1986). The infant's role in mother-infant communication. *Journal of Child Language*, 13, 15-29.
- Nadel, J., Carchon, I., Kervella, C., Marcelli, D., & Réserbat-Plantey, D. (1999). Expectancies for social contingency in 2-month-olds. *Developmental Science*, 2:2, 164-173.
- Nagy, E., & Molnar, P. (2004). Homo imitand or homo provocans? Human imprinting model of neonatal imitation. *Infant Behavior & Development*, 27, 54-63.
- Negayama, K. (1999). Development of Reactions to Pain of Inoculation in Children and their Mothers. *International Journal of Behavioral Development*, 23 (3), 731-746.
- Panneton Cooper, R., Abraham, J., Berman, S., & Staska, M. (1997). The Development of Infants' Preference for Motherese. *Infant Behavior & Development*, 20 (4), 477-488.
- Panneton Cooper, R., & Aslin, R. N. (1990). Preference of Infant-directed Speech in the First Month after Birth. *Child Development*, 61, 1584-1595.
- Pierrehumbert, B., Miljkovitch, R., Plancherel, B. Halfon, O., & Ansermet, F. (2000). Attachment and Temperament in Early Childhood: Implications for Later Behavior Problems. *Infant & Child Development*, 9, 17-32.
- Posner, M., & Rothbart, M. K. (1998). Attention, self-regulation and consciousness. *Philosophical transactions of the Royal Society of London*, 353, 1915-1927.
- Reddy, V., Hay, D., Murray, L., & Trevarthen, C. (1997). Communication in Infancy: Mutual Regulation of Affect and Attention. In G. Bremner, A. Slater & G. Butterworth (Eds.), *Infant Development* (pp. 247-274). East Sussex: Psychology Press.
- Rochat, P., Neisser, U., & Marian, V. (1998). Are young infants sensitive to interpersonal contingency? *Infant Behavior & Development*, 21 (2), 355-366.

- Ross, D. M., & Ross, S. A. (1988). *Childhood Pain. Current issues, research, and management*. Baltimore: Urban & Schwarzenberg.
- Rothbart, M. K., & Derryberry, D. (1981). Development of individual differences in temperament. In M. E. Lamb & A. L. Brown (Eds.), *Advances in developmental psychology (Vol. 1)* (pp. 37-86). Hillsdale, NJ: Erlbaum.
- Rothbart, M. K., Posner, M. I., & Rosicky, J. (1994). Orienting in normal and pathological development. *Development and Psychopathology*, 6, 635-652.
- Ruspini, E. (2002). *Introduction to longitudinal research*. London: Routledge, Taylor & Francis Group.
- Russell, J. (1999). *Agency. It's Role in Mental Development*. Cambridge: Erlbaum, Taylor & Francis Ltd.
- Sameroff, A. J. (2004). Ports of Entry and the Dynamics of Mother-Infant Interventions. In A. J. Sameroff, S. C. McDonough & K. L. Rosenblum (Eds.), *Treating Parent-Infant Relationship Problems. Strategies for Interventions* (pp. 3-28). New York: The Guilford Press.
- Sameroff, A. J. (2005). The Science of Infancy: Academic, Social, and Political Agendas. *Infancy*, 7 (3), 219-242.
- Sameroff, A., & MacKenzie, M., J. (2003a). A Quarter-Century of the Transactional Model: How Have Things Changed? *Zero to Three, September 2003*, 14-22.
- Sameroff, A., & MacKenzie, M., J. (2003b). Research strategies for capturing transactional models of development: The limits of the possible. *Development and Psychopathology*, 15, 613-640.
- Schore, A. N. (1994). *Affect regulation and the origin of the self: The neurobiology of emotional development*. Mahwah, New Jersey: Erlbaum.
- Schore, A. N. (2001). Contribution from the decade of the brain to infant mental health: An overview. *Infant Mental Health Journal, Vol. 22*, 1-56.
- Siegel, D. J. (1999). *The developing Mind*. New York: The Guilford Press.
- Siegel, D. J. (2001). Toward an interpersonal neurobiology of the developing mind: Attachment relationships, "mindsight", and neural integration. *Infant Mental Health Journal, Vol. 22 (1-2)*, 67-94.
- Snow, C. E. (1977). The development of conversation between mothers and babies. *Journal of Child language*, 4, 1-22.
- Stern, D. (1974). Mother and Infant at Play: The Dyadic Interaction Involving Facial, Vocal, and Gaze Behaviors. In L. A. Rosenblum & M. Lewis (Eds.), *The Effect of*

- the infant on its caregiver* (pp. 187- 213). Oxford, England: Wiley-Interscience.
- Stern, D., Spieker, S., Barnett, R., & MacKain, K. (1983). The Prosody of maternal speech: Infant age and context related changes. *Journal of Child Language*, *10*, 1-15.
- Stormark, K. M., & Braarud, H. C. (2004). Infants' sensitivity to social contingency: a "double video" study of face-to-face communication between 2- and-4 month-olds and their mothers. *Infant Behavior & Development*, *27*, 195-203.
- Sweet, S., & McGrath, P. J. (1998). Relative Importance of Mothers' Versus Medical Staffs' Behavior in the Prediction of Infant Immunization Pain Behavior. *Journal of Pediatric Psychology*, *23*, (4), pp. 249-256.
- Sweet, S. D., McGrath, P. J., & Symons, D. (1999). The roles of child reactivity and parenting context in infant pain response. *Pain*, *80*, 655-661.
- Trevarthen, C. (1979). Communication and cooperation in early infancy: a description of primary intersubjectivity. In M. Bullowa (Ed.), *Before speech* (pp. 321-347). Cambridge: Cambridge University Press.
- Trevarthen, C. (1980). The Foundations of Intersubjectivity: Development of Interpersonal and Cooperative Understanding in Infants. In D. Olson (Ed.), *The social foundation of language and thought: Essays in honour of J. S. Bruner* (pp. 316-342). New York: W. W. Norton.
- Trevarthen, C. (1982). The primary motives for cooperative understanding. I G. Butterworth & P. Light (Eds.), *Social cognition. Studies of the Development of Understanding* (pp. 77-109). Brighton: Harvester Press.
- Trevarthen, C. (1984). Emotions in Infancy: Regulators of contact and relationships with persons. In K. R. Scherer & P. Ekman (Eds.), *Approaches to Emotions* (pp. 129-157). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Trevarthen, C. (1998). The concept and foundations of infant intersubjectivity. In S. Bråten (Ed.), *Intersubjective communication and emotion in early ontogeny* (pp. 15-46). Cambridge: Cambridge University Press.
- Trevarthen, C. (2001). Intrinsic motives for companionship in understanding: Their origin, development, and significance for infant mental health. *Infant Mental Health Journal*, *Vol. 22* (1-2), 95-131.
- Trevarthen, C. (2003). Infant Psychology is an Evolving Culture. *Human Development*, *46*, 233-246.
- Trevarthen, C., & Aitken, K. J. (2001). Infant Intersubjectivity: Research, Theory, and

- Clinical Applications. *Journal of Child Psychology and Psychiatry*, Vol. 42, No. 1, 3-48.
- Trevarthen, C., Kokkinaki, T., & Fiamenghi Jr., G. A. (1999). What infants' imitations communicate: with mothers, with fathers and with peers. In J. Nadel & G. Butterworth (Eds.), *Imitation in Infancy* (pp. 127-185). Cambridge: Cambridge University Press.
- Tronick, E. Z. (1989). Emotions and Emotional Communication in Infants. *American Psychologist*, 44 (No. 2), 112-119.
- Tronick, E. Z. (2003). Emotions and emotional communication in infants. New thoughts on mutual regulation: co-creation and uniqueness- 2002. In J. Raphael-Leff (Ed.), *Parent-infant psychodynamics: wild things, mirrors and ghosts* (pp. 35-53). London: Whurr Publishers.
- Tronick, E., Als, H., Adamson, L., Wise, S., & Brazelton, T. B. (1978). The infant's response to entrapment between contradictory messages in face-to-face interaction. *Journal of American Academy of Child Psychiatry*, 17, 1-13.
- Užgiris, I. C. (1999). Imitation as activity: its developmental aspects. In J. Nadel & G. Butterworth (Eds.), *Imitation in Infancy* (pp. 186-206). Cambridge: Cambridge University Press.
- Wagner, M., Kutash, K., Duchnowski, A., J., & Epstein, M., H. (2005). The Special Education Elementary Longitudinal Study and the National Longitudinal Transition Study: Study Designs and Implications for Children and Youth With Emotional Disturbance. *Journal of Emotional and Behavioral Disorders*, Vol.13, 1, 25-41.
- Waters, E., Wippman, J., & Sroufe, L. A. (1979). Attachment, Positive Affect, and Competence in the Peer Group: Two Studies in Construct Validation. *Child Development*, 50, 821-879.
- Weinberg, M. K., & Tronick, E. Z. (1994). Beyond the Face: An Empirical Study of Infant Affective Configuration of Facial, Vocal, Gestural, and Regulatory Behaviors. *Child Development*, 65, 1503-1515.
- Weinfield, N. S., Sroufe, L. A., Egeland, B., & Carlson, E. A. (1999). Internal Working Models in Attachment Relationship: A Construct Revisited. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of Attachment* (pp. 68-88). New York: The Guilford Press.
- Zeanah, C. H., Boris, N. W., Scott Heller, S., Hinshaw-Fuselier, S., Larrieu, J. A., Lewis,

M., Palomino, R., Rovaris, M., & Valliere, J. (1997). Relationship Assessment in Infant Mental Health. *Infant Mental Health Journal, Vol. 18(2)*, 182-197.