# EARLY RELATIONSHIP BETWEEN VERY PRETERM INFANT AND MOTHER: THE ROLE OF INFANT, MATERNAL AND DYADIC FACTORS

by

Riikka Korja

From the Department of Child Psychiatry,
University of Turku
Turku, Finland.

Supervised by

Professor Jorma Piha, MD
Department of Child Psychiatry
University of Turku & Turku University Hospital
Turku, Finland

Docent Liisa Lehtonen, MD
Department of Pediatrics
Turku University Hospital
Turku, Finland

**Reviewed by**

Professor Raija-Leena Punamäki
Department of Psychology
University of Tampere
Tampere, Finland

and

Mirjami Mäntymaa, MD, PhD
Department of Child Psychiatry
Tampere University Hospital
Tampere, Finland

**Opponent**

Docent Mirjam Kalland
The Faculty of Social Sciences
University of Helsinki
Helsinki, Finland

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*To Miikka,*
*Unna and Isla*

# ABSTRACT

Riikka Korja
**Early relationship between very preterm infant and mother:
The role of infant, maternal and dyadic factors.**
Department of Child Psychiatry, University of Turku

The primary purpose was to assess the quality and the organization of mother–infant relationship in Finnish firstborn singleton preterm infants and their mothers. In addition, the aim was to study modifying factors such as infant crying, caregiver holding and maternal depression in relation to the mother–preterm infant relationship.

The study groups included 32 (Study I-II) and 38 (Study III-IV) preterm infants (< 1501 g or < 32 weeks) and 46 full term infants. The mother–infant interaction was assessed using PCERA at 6 and 12 months of corrected age. Maternal representations were studied using WMCI at 12 months of infant's corrected age. Baby Day Diary was used to explore the infant's crying and the caregiver's holding behaviors at 5 months of corrected age. Maternal depression was evaluated using EPDS at 6 months of infant's corrected age.

This study showed no differences in the maternal attachment classifications, or maternal or dyadic interaction between groups of preterm and full term infants. However, preterm infants demonstrated more sober and withdrawn mood and lower quality in the play and attention skills than full term infants in the interaction situation at 12 months. This study also showed that prolonged crying and maternal depression are negatively related to the mother–infant interaction in the preterm group. Interestingly, the frequent but soothable infant's crying was positively related to the duration of holding and the duration of holding was positively related to the quality of mother–infant interaction only in the preterm group.

The results of the present study suggest that preterm birth does not, in and of itself, form a risk for maternal attachment or for maternal or dyadic interaction, but together with other risk factors preterm birth may negatively influence the mother–infant relationship. The results also suggests that mothers and their preterm infants develop a different kind of interaction style where the infant's crying may be a trigger for holding and thus for positive, mutual and reciprocal interaction. This may be an adaptive mechanism protecting the mother–preterm infant relationship.

**Key words:** preterm birth, mother–infant interaction, maternal representations, maternal depression, infant's crying, holding

# TIIVISTELMÄ

Riikka Korja
**Pienipainoisen keskosen ja äidin varhainen suhde:**
**Lapsen, äidin ja dyadisten muuttujien vaikutus**
Lastenpsykiatrian yksikkö, Turun yliopisto

Tämän tutkimuksen tavoitteena oli tutkia keskosvauvan ja äidin varhaista suhdetta. Tutkimuksessa selvitettiin myös vauvan itkukäyttäytymisen, vauvan sylissä olon ja äidin masentuneisuuden yhteyttä äidin ja keskosvauvan varhaiseen suhteeseen.

Tutkimusryhmät koostuivat 32:sta (tutkimus I-II) ja 38:sta (tutkimus III-IV) keskosena syntyneestä vauvasta (syntymäpaino < 1501 g tai GI < 32 viikkoa) sekä 46:sta täysiaikaisena syntyneestä terveestä verrokkivauvasta. Lapsen ja äidin vuorovaikutusta arvioitiin 6 ja 12 kuukauden iässä (korjattu ikä) PCERA-menetelmällä. Äidin mielikuvia lapsestaan tutkittiin WMCI-haastattelulla, kun lapsi oli 12 kuukautta. Baby Day Diary -menetelmää käytettiin vauvan itkukäyttäytymisen ja sylissä olon keston mittaamisessa vauvan ollessa 5 kuukautta. Äidin masentuneisuutta arvioitiin EDPS-lomakkeella, kun lapsi oli 6 kuukautta.

Tulokset osoittivat, että turvallisten kiintymyssuhdemielikuvien määrä tai vuorovaikutuksen laatu eivät keskosvauvan äideillä eronneet täysiaikaisina syntyneiden vauvojen äitien vastaavista. Ryhmien välillä ei löytynyt eroja myöskään dyadisen vuorovaikutuksen laadussa. Keskosena syntyneet lapset olivat kuitenkin vetäytyvämpiä ja heillä oli laadullisesti heikommat keskittymisen ja leikin taidot vuorovaikutustilanteessa 12 kuukauden iässä täysiaikaisina syntyneisiin lapsiin nähden. Lisäksi äidin masentuneisuus ja lapsen pitkittynyt itkuisuus olivat negatiivisessa yhteydessä vuorovaikutuksen laatuun keskosvauvojen ryhmässä. Vauvan itkukertojen määrän, sylissä olon keston sekä äidin ja vauvan vuorovaikutuksen laadun välillä löytyi positiivinen yhteys ainoastaan keskosena syntyneiden lasten ryhmässä.

Tulostemme perusteelle toteamme, että lapsen ennenaikainen syntymä itsessään ei näytä muodostavan riskiä äidin vuorovaikutuksen laadulle tai turvalliselle kiintymyssuhteelle. Yhdessä muiden riskitekijöiden kanssa keskosuus kuitenkin altistaa vauvat ja heidän äitinsä varhaisen vuorovaikutuksen ongelmille. Lisäksi tuloksemme viittaavat siihen, että vauvan itku ja siitä seuraava sylissä olo toimivat suojaavana mekanismina pienipainoisen keskosen ja äidin varhaisessa suhteessa.

**Avainsanat:** Keskossyntymä, äidin ja vauvan vuorovaikutus, äidin kiintymyssuhdemielikuvat, äidin masennus, vauvan itku, sylissä pito

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# ABBREVIATIONS

EPDS        Edinburgh Postnatal Depression Scale

GA          Gestational Age

KC          Kangaroo Care

NICU        Neonatal Intensive Care Unit

PCERA       Parent Child Early Relational Assessment

SGA         Small for the Gestational Age

SES         Socio-Economic Status

VLBW        Very Low Birth Weight (< 1501g)

WMCI        Working Model of the Child Interview

# LIST OF ORIGINAL COMMUNICATIONS

This thesis is based on the following papers, which are referred to in the text with Roman numerals I – IV.

I       Korja. R., Maunu. J., Kirjavainen. J., Savonlahti. E., Haataja. L., Lapinleimu. H., Manninen. H., Piha. J., Lehtonen. L. and the PIPARI Study Group. (2008) Mother–infant interaction is influenced by the amount of holding in preterm infants. Early Human Development, 84(4): 257-267.

II.     Korja. R., Savonlahti, E., Ahlqvist-Björkroth, S., Stolt, S., Haataja, L., Lapinleimu, H., Piha, J., Lehtonen, L. and the PIPARI study group. (2008) Maternal depression is associated with mother–infant interaction in preterm infants. Acta Paediatrics, 97(6):724-30.

III.    Korja, R., Savonlahti, E., Haataja, L., Lapinleimu, H., Manninen, H., Piha, J., Lehtonen, L., and the PIPARI Study Group. Attachment representations in mothers of preterm infants. Infant Behavior & Development, 32 (3) 239-350.

IV.     Korja, R., Ahlqvist-Björkroth, S., Savonlahti, E., Stolt, S., Haataja, L., Lapinleimu, H., Piha, J., Lehtonen, L. and the PIPARI study group. How are maternal attachment representations related to the quality of mother–infant interaction in preterm and full term infants? Submitted.

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# 1   INTRODUCTION

The mortality of preterm infants has clearly decreased during recent decades. However, preterm infants are still at higher risk than full term infants for both short- and long-term complications, including impairments in growth and neurosensory development as well as in emotional and behavioral development. At greatest risk are those infants born very preterm (< 32 weeks of gestation) or those with very low birth weight (< 1500 g).This group comprises 1% of all newborns in Finland (National Birth Register, National Institute for Health and Welfare).

Preterm birth is a stressful event for families in several ways. Preterm birth interrupts the parents' antenatal bonding to the infant and preparation for the infant's birth. Furthermore, fear for the infant's safety and of the potential development of a disability increases parental stress and anxiety. In addition, the preterm infant's intensive care inevitably causes some degree of separation between the parent and the infant. Consequently, preterm birth has been assumed to be a risk factor for the development of the parent–infant relationship.

Studies on the mother–infant relationship have provided important insight into the development of the mother–infant relationship in the specific risk situation of preterm birth. However, the data are inconsistent. Some of the inconsistency can be explained by the relatively recent development of family-centered neonatal care. Family-centered care encourages the parents to be present and actively involves them in the care of the infant. For instance, Kangaroo Care is applied more widely today, and infant mental health professionals are in many places an integral part of the care team. In addition, background factors may contribute to inconsistencies between the studies, as several studies have included a bias in socioeconomic, cultural and family background factors between preterm infants and their controls. Furthermore, as smaller and more immature preterm infants are surviving, the interaction between them and their mothers exhibits specific characteristics that may affect the results of new studies about the mother–preterm infant relationship.

In the present study, the quality of the mother–preterm infant relationship was evaluated at a hospital with an advanced approach to family-centered neonatal care and in a group of preterm infants without a bias in socioeconomic and cultural background. The assessment of the mother–preterm infant relationship was based on both interviews about maternal attachment representations and observation of mother–infant interaction. Both supporting and impairing factors affecting the quality of the mother–preterm infant relationship were explored.

# 2 REVIEW OF THE LITERATURE

## 2.1 The organization of the mother–infant relationship

The mother–infant relationship is a complex system, which is affected by several factors from both the infant's and the mother's side of the dyad. Slade, Belsky, Aber and Phelps (1999) proposed that many factors affecting mother-infant relationship are associated with the actual infant, the relationship and the family situation. Such factors may include the parents' socioeconomic background, relationship or psychological well-being or the infant's temperament or biological vulnerability (Huth-Bocks, Levendosky, Bogat, & von Eye, 2004; Slade et al., 1999). Preterm birth is one potential risk factor.

Stern-Brushweiler and Stern (1989) have presented a basic model of characterizing and assessing the infant–parent relationship focusing on four components of the relationship (Figure 1). These components include interaction and subjective representations of each partner. The understanding of interactive behaviors arrives at a more profound level if the parent's subjective experiences of the relationship are also explored. The observed interaction behavior and affect indicates how the parent's subjective experiences are connected to the relationship. In the model created by Stern-Brushweiler and Stern (1989), the mother–infant relationship is seen as an open system, where these four components of the relationship affect each other dynamically.

A good quality of mother–child interaction behavior facilitates the infant's later socio-emotional, behavioral and cognitive development and is even related to the physical health of the child (Mäntymaa, 2006). The infant needs the parent's sensitive, contingent and predictable interaction and care to become regulated physiologically and psychologically (Bell & Ainsworth, 1972; Emde, 1981; Greenspan & Lourie, 1981). Furthermore, the infant needs to experience reciprocal, affectively involved interaction with the parent to become interested in social interactions and to develop secure attachment relationships (Ainsworth, Bell, Stayton, 1972; Emde, 1981; Lamb & Easterbrook, 1981). Based on the parent–infant interaction, the child forms an attachment style during the first year (Bowlby, 1969, 1973, 1980; Goldberg, 2000). The first attachment figure is usually the mother, but it can be any individual who has been consistently responsive (Goldberg, 2000). During the development of an attachment relationship, the infant forms internal representations about the experiences of the relationship and caretaking (Bowlby, 1969, 1982). Internal attachment representations include social, emotional, cognitive and behavioral components. These representations direct the child's behavior in future social relations (Bowlby, 1982). At one year of age, when the infant reaches the preferred attachment style, the infant's attachment patterns can be classified

into three main categories: 1) secure, 2) insecure avoidant and 3) insecure resistant (Ainsworth, Bell, Stayton, 1972). Later, the category insecure disorganized was added (Main and Solomon, 1986). Attachment patterns can be assessed using a Strange Situation Test, where the infant's response to the parent's brief separations and reunions are evaluated (Ainsworth, Blehar, Waters, & Wall, 1978).

From the parent's side, the bonding process between the infant and the parent is directed by the parent's attachment representations of her or his child (Stern, 1995; Zeanah & Benoit, 1995). These parental attachment representations are affected by factors associated with the actual infant and life situation and also by the parent's attachment representations regarding his or her own childhood (Slade, Belsky, Aber & Phelps,1999). The adults' attachment reprentations regarding their own childhood can be classified into four categories: autonomous, dismissing, preoccupied and disorganized, which can be assessed using the Adult Attachment Interview (George, Kaplan & Main, 1986).

For prospective mothers, attachment representations regarding their infant begin to form during pregnancy (Benoit, Parker, & Zeanah, 1997; Stern, 1995; Zeanah & Benoit, 1995). Maternal representations are shown to be moderately stable from pregnancy through the first year of the infant's life (Benoit, Parker, & Zeanah, 1997; Theran, Levendosky, Bogat, & Huth-Bocks, 2005) and, as they strongly direct the way the mother interacts with the infant, they thus also affect the infant's attachment development (Zeanah, Benoit, Hirschberg, Barton, & Regan, 1994). Zeanah et al. (1994) have developed the Working Model of the Child Interview (WMCI) to study a parent's attachment representations of his or her child. In their studies, they describe three main categories of parental representation patterns: balanced, disengaged and distorted (Benoit et al., 1997; Zeanah et al., 1994). These categories are analogical with the autonomous, dismissing and preoccupied adult attachment representation categories (George, Kaplan, & Main 1985; Main, 1995).

In spite of the suggestion that the assessment of the mother–infant relationship should include both observation of the dyad's interaction behavior and an interview eliciting the parent's subjective experience (Zeanah, Larrieu, Heller et al. 2002), most studies continue to focus on one of three topics: interaction behavior, the infant's attachment or the parent's subjective experiences. In the present study, both the quality of the mother–infant interaction behavior and maternal attachment representations were evaluated. Furthermore, the relation between mother–infant interaction and maternal representations was assessed.
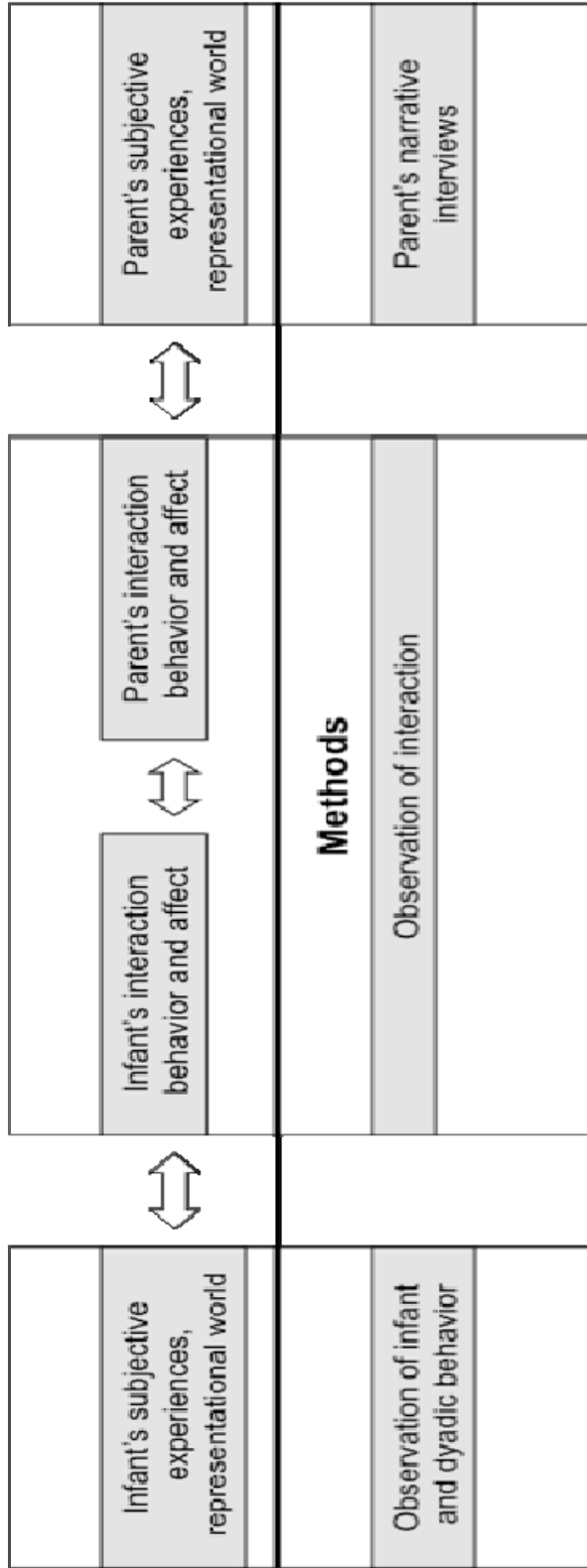
**Figure 1.** Model of internal and external components and assessment methods of infant–parent relationships. Modified from the model developed by Stern & Stern-Brushweiler (1989).

## 2.2 The organization of the mother-preterm infant relationship

### 2.2.1 Mother–infant interaction and infant's attachment in preterm infants and their mothers

Previous studies have shown that interactional behavior and affect appear to be different in preterm infant–mother dyads than in full term infants and their mothers. Minde et al. (1985) showed that preterm infants were less alert than full term infants at one month after discharge. Mothers of preterm infants talked and looked more and touched and smiled less than mothers of full term infants during the first three months. Differences in the infant's behavior were most evident during the first month. Mothers showed differences in their interaction at all times between the first and third months after the infant's birth. Minde et al. (1985) suggested that an average mother of a preterm infant tries to provide her infant with compensatory care, including verbalization, looking in the face and instrumental touch, but that the mother delivers this with less affect, including less smiling and less non-instrumental touching. The study by Schmucker et al. (2005) was in line with Minde et al.'s (1985) study showing that preterm infants and their mothers were more vocally active and responsive in interaction situations at 3 months of the infant's corrected age than full term infants and their mothers. Furthermore, preterm infants and their mothers were less facially responsive during the interaction than mothers of full term infants (Schmucker et al., 2005). Schmucker et al. (2005) suggested that the vocal interaction may be particularly preferred by preterm infants and their mothers and compensate for the less-responsive facial interactions.

In contrast to Minde et al.'s (1985) and Schmucker et al.'s (2005) studies, Gerner (1999) did not find differences at 3 months of age between preterm and full term infants and their mothers during still-face interaction situations. However, preterm infants and their mothers showed significantly lower interaction quality in feeding situations at 6 months of age (Gerner, 1999). Gerner (1999) suggested that the infant's own interaction skills contribute more at 6 months of age than in the earlier assessment, and that the mothers of preterm infants are no longer successful in their attempts to compensate for difficulties during the demanding feeding situation. A study by Muller-Nix et al. (2004) is in line with Gerner's (1999) study showing that mothers of preterm infants were less sensitive and more controlling than mothers of full term infants with their infant in dyadic play at 6 months of the infant's age. However, the preterm infant's interaction behavior did not differ from full term infants at this age point (Muller-Nix et al., 2004). Two different mother–infant interaction patterns were described in the cohort of Muller-Nix et al. (2004). Mothers of full term infants had a more cooperative interaction pattern, which is characterized by higher sensitivity and lower intrusivity, than mothers of preterm infants (Forcada-Guex, Pierrehumbert, Borghini, Moessinger, & Muller-Nix, 2005), while mothers of preterm infants had more a controlling interaction pattern,

which is characterized by higher intrusiveness, over-activity and lower sensitivity, than mothers of full term infants (Forcada-Guex et al. 2005).

Interestingly, Muller-Nix et al. (2003) showed that there were no differences in maternal interaction behavior between preterm and full term dyads at 18 months of the infant's age. However, the preterm infant's interactional behavior showed more passivity and compulsive-compliance behavior than that of full term infants at 18 months. Forcada-Guex et al. (2005) proposed that the mother's controlling interaction pattern at 6 months of the infant's age was related to the preterm infant's lower quality of interaction and behavioral and developmental problems at 18 months of the infant's age. In contrast to the findings by Muller-Nix et al. (2004) and Forcada-Guex et al. (2005), Greenberg and Crnic (1988) did not find any differences in mother–infant interaction at 2 years of the infant's age. They suggested that differences in the mother–infant interaction are not evident at a later age, when the level of the preterm infant's immaturity and maternal stress and anxiety have decreased. Furthermore, they suggested that environmental factors, such as different caregiving styles and social support, may compensate for the effects of preterm birth (Greenberg & Crnic, 1988).

In conclusion, previous studies have shown that the differences in maternal interaction behavior between mothers of preterm infants and mothers of full term infants seem to be most evident during the first six months of life. Differences in the preterm infant's interaction behavior seem to emerge after six months of life, when the infant's own interaction skills are better formulated and play a more significant role. Typical areas of concern in the interaction behavior of mothers of preterm infants have been shown to be lower sensitivity, a lack of facial interaction and higher intrusiveness. In the preterm infant's interaction behavior, the most frequent areas of concern are passivity and lack of alertness. The explanations for the reasons behind the differences in mother–infant interaction between preterm and full term populations have varied. One explanation is that the differences in the maternal interaction behavior are seen as adaptive responses to the preterm infant's immaturity and deficits in responsiveness. The other explanation is that differences are caused by maternal stress and the interrupted bonding process, which may lead to higher intrusiveness and lower sensitivity.

On the basis of what is known about the quality of maternal interaction behavior in preterm populations, we might expect that preterm infants would be at an increased risk for insecure attachment. However, several previous studies on preterm infant attachment have indicated that insecure attachment patterns are not over-represented in preterm infants when compared to full term infants as assessed with the Strange Situation Test at one year (Brisch, Bechinger, Betzler et al., 2005; Brown & Bakeman, 1980; Easterbrooks, 1989; Goldberg, Perrotta, & Minde, 1986). Several authors have thus argued that, in spite of possible early interactional differences and difficulties, preterm infants

are as likely to form secure attachments to their mothers as full term infants. These findings regarding preterm infant attachment give further support to the speculation that parents of preterm infants adapt to the special needs of their children. Goldberg et al. (1986) indicated that, even in the extremely vulnerable group of preterm infants, the majority of mothers and infants established a style of interaction that fostered development of a secure attachment in spite of early difficulties. It has been suggested that a child's serious illness challenges the mother to adapt to and compensate for her infant's limitations (Goldberg, 1986). This modifies the mother–infant interaction to ensure the infant's later secure attachment. Brisch et al. (2005) showed that a preterm infant's significant neurological impairments were related to insecure attachment. They suggested that a preterm infant's neurological impairment during the first year of life may keep the mother's state of anxiety and stress levels high, which may contribute to the development of the infant's attachment (Brisch et al., 2005).

## 2.2.2 Attachment representations in mothers of preterm infants

During pregnancy, gestational weeks 24 -32 are the most crucial period for the development of maternal attachment representations of the child and the mother-child relationship (Ammaniti, Baumgartner, Candelori et al., 1992; Cohen & Slade, 2000). During this period, the mother has to work through her mental representations of herself as a woman and as a mother (Ammaniti et al., 1992; Cohen & Slade, 2000; Winnicott, 1958). The mother's representations of the idealized infant shift toward the real infant during the last trimester of pregnancy, and this development prepares the mother for the separation from the infant (Winnicott, 1958). Preterm birth interrupts the development of maternal attachment representations, and, therefore, the mother's mental representation of the infant and the real preterm infant often differ (Broden, 2004; Kalland, 2003). Generally, the mother of the preterm infant has not been able to prepare herself for separation from the infant (Broden, 2004; Kalland, 2003). The interrupted representation process, a traumatic birth experience, early separation and a fear for the infant's safety may complicate the mother's attachment process.

There are only a few studies about the attachment representations of mothers of preterm infants. Brisch et al. (2005) studied mothers' attachment representations regarding their own childhood relationships. Their study indicated that mothers of preterm infants were comparable in their attachment classifications to parents of full term infants in middle-class samples taken from other longitudinal studies (van IJzendoorn & Bakermans-Kranenburg, 1996). As far as we know, the mother's attachment representations of her preterm infant have been studied using the WMCI method in only one previous study (Borghini, Pierrehumbert, Miljkovitch, Muller-Nix, Forcada-Guex, & Ansermet, 2006). There were fewer insecure maternal attachment representations in the preterm population than in the full term population at 6 and 18 months of the infant's age. There were also differences in the qualitative characteristics of the

maternal representations between the mothers of preterm infants and those of full term infants. The mothers of preterm infants had lower coherence, less richness of perceptions, less openness to change, lower intensity of involvement and less acceptance in their attachment representations compared to the mothers of full term infants. In addition, the mothers of preterm infants had more fear for the infant's safety. The study by Borghini et al. (2006) did not control for the socio-economic differences between the preterm and full term infants, which calls into question the reliability of the results.

### 2.2.3 The relations between mother–infant interaction, the infant's attachment and maternal representations

The relations between the parents' attachment representations regarding their child and the infants' attachment have been studied widely, showing that a typology of the parents' attachment representations of their infants are systematically related to infant attachment classifications (Zeanah, Benoit, Barton, Regan, Hirshberg, & Lipsitt, 1993; Zeanah, Benoit, Hirschberg, Barton, & Regan, 1994). Furthermore, the parent's attachment classifications regarding their own childhood have been shown to be associated with the infant's attachment categories (van IJzendoorn & Bakermans-Kranenburg, 1997). In contrast to studies of full term populations, Brisch et al. (2005) indicated that, in a preterm population, the mothers' attachment representations based on their own childhoods were not related to the preterm infants' attachment classifications. They suggested that active support from the NICU staff allows parents with dismissing or preoccupied attachment to be closer and more connected with their preterm infant than they might have been with a full term infant in a home environment.

A few studies have investigated the relationship between parental attachment representations regarding the infant and mother–infant interaction in full term infants and their mothers. Rosenblum, McDonough, Muzik, Miller and Sameroff (2002) found that, during both "Still Face" and "Reengagement" episodes, infants of mothers with non-balanced representations showed less positive affect than infants of mothers with balanced representations. Rosenblum et al. (2002) concluded that both infants and mothers in the group exhibiting non-balanced representations expressed less capacity to effectively engage in the process of reparative interaction after a short disruption. In addition, Szewczyk-Sokolowski, Hans, Bernstein and Cox (2007) showed that mothers with disengaged attachment representations demonstrated less sensitive, more passive, and less encouraging and guiding maternal behavior in interaction situations. There are no studies about the associations between the quality of mother–infant interaction and maternal attachment representations in preterm populations. However, a holistic perspective including assessment of interaction and representations would increase the understanding of the organization of the mother–preterm infant relationship.

## 2.3 Factors affecting the mother–preterm infant relationship

The origins of the particularities of the mother–preterm infant relationship are unclear. As the preterm birth is a stressful situation for both the mother and the infant, we can assume that there are several factors affecting the mother–preterm infant relationship that can originate on either the infant's or the parent's side. Previous studies have shown that risk factors for the development of the preterm infant–mother relationship include, e.g., the infant's poor physical condition (Minde et al., 1985; Muller-Nix et al., 2004), the mother's traumatic experience of pregnancy and delivery (Muller-Nix et al., 2004), maternal anxiety (Schmucker et al., 2005; Wijnroks, 1999), lack of maternal proximity (Feldman, Eidelman, Sirota, & Weller, 2002; Feldman, Weller, Sirota & Eidelman, 2002 ) and low socioeconomic status (Gerner, 1999; Wille, 1991).

### 2.3.1 The preterm infant's physical condition

It has been suggested that the preterm infant's immaturity and lack of social responsiveness are factors that make it more difficult for the mother and infant to interact with each other. Muller-Nix et al. (2003) found that mothers of preterm infants with higher number of medical risk factors (high-risk preterm infants) were less sensitive and more controlling than mothers of preterm infants with a lower number of medical risk factors (low-risk preterm infants) or full term infants in dyadic play at 6 months of the infant's age. Furthermore, Minde et al. (1985) showed that the degree and severity of the premature infant's recorded medical problems were related to the mother's style of interaction with her infant (Minde et al., 1985). Mothers of ill infants smiled and looked less at their infants than mothers with healthy preterm infants. Both Minde et al. (1985) and Muller-Nix et al. (2003) considered that the mother's interaction behavior could be either intrusive or adaptive to the specific difficulties presented by the preterm infant's immaturity. Minde et al. (1985) also suggested that the preterm infant's immaturity directs the mother toward more compensatory care. Greenberg and Crnic (1988) found contradictory results indicating more positive interaction in mothers of high-risk preterm infants compared to mothers of low-risk preterm infants. Furthermore, Borghini et al. (2006) indicated more balanced attachment representations in mothers of high-risk preterm infants compared to mothers of low-risk preterm infants. Borghini et al. (2005) suggested that concern and fear for the infant's safety might encourage parental involvement.

### 2.3.2 The preterm infant's behavior: fussing and crying

Preterm infants are at a higher risk for a variety of behavioral difficulties during infancy and childhood that can make parenting difficult (Minde, 2000). During infancy, the one clear component of difficult behavior is the infant's crying and fussing. Persistent crying problems that last beyond three months of life have

been indicated to be related to later sleeping and feeding problems and to hyperactivity and other behavioral problems in full term population (Wolke, Rizzo, & Woods, 2002; Wolke, Sohne, Riegel, Ohrt, & Sterlund, 1998). However, the origin of crying is still unclear, and crying can be also as a sign of vigor (Lummaa, Vuorisalo, Barr, & Lehtonen, 1998). In full term infants, crying reaches a peak during the second month of life, after which the amount of crying declines gradually during the subsequent months (Barr, 1990; Brazelton, 1962; St James-Roberts & Halil, 1991). It has been suggested that the crying pattern is biologically based but may be modified by environmental factors, such as caregiving styles and physical holding (St James-Roberts, Conro, & Wilsher, 1998). Observations on mothers and their infants in traditional, non-industrialized societies suggest that crying amounts are low in such societies, where infants are held for most of the day and fed on demand (Barr et al., 1991; Hewlett, Lamb, Shannon, Leyendecker, & Schoelmerich, 1998).

According to previous studies, preterm infants exhibit difficulties in negative affect and state regulation and more irritability (Ferrari, Grosoli, Fontana, & Cavazzuti, 1983; Thoman & Graham, 1986; Wolf, Koldewijn, Beelen, Smith, Hedlund, & de Groot, 2002). However, preterm infants have been shown to have comparable amounts of crying and fussing as full term infants in the home environment (Barr, Chen, Hopkins, & Westra, 1996; Maunu, Kirjavainen, Korja et al., 2006). By 5 months of corrected age, crying and fussing have decreased to a lower, more stable level, in both preterm and full term infants (Maunu et al., 2006). Brain injuries related to prematurity do not increase the amount of fussing and crying in the home environment (Maunu et al., 2006). However, Beckwith and Rodning (1998) showed that preterm infants who were either born very early or had very low birth weight and who also had more respiratory distress cried and fussed less than low-risk preterm infants. They suggested that a preterm infant's crying and fussing indicates the infant's robustness and is a sign of vigor (Beckwith & Rodning, 1998).

In healthy full term infants, crying and irritability have been shown to be negatively related to mother–infant interaction, showing less involvement and responsiviness in mothers of irritable infants than mothers of non-irritable infants (van den Boom & Hoeksma, 1994; Räihä, Lehtonen, Huhtala, Saleva, & Korvenranta, 2002). However, Beckwith and Rodning (1998) showed that the preterm infant's irritability was associated positively with maternal responsiveness and the infant's later competence. Meier, Wolke, Gutbrod and Rus (2003) did not find the relationship between irritable behavior in preterm infants and maternal sensitivity during the period from term to 3 months of corrected age.

### 2.3.3 Maternal proximity and caregiving factors

Preterm birth before 32 gestational weeks inevitably causes the separation between the mother and the infant due to the neonatal intensive care. As

newborn infants and their mothers are dependent on each other in several ways, the early separation forms a challenge for the development of early bonding in the group of preterm infants and their mothers. Consequently, a lack of physical contact has been assumed to be one risk factor affecting the development of the mother–infant relationship in preterm populations. The amount and the quality of physical contact have been shown to be associated with full term infants' development in several domains, including social, cognitive, and physical development (Hertenstein, 2002). Furthermore, positive physical touch increases the amount of infant smiling and infant and parent vocalizing during parent-infant interaction (Pelaez-Nogueras, Gewirts, Field, and Cigales, 1996).

Several studies have indicated the positive effect of different touch interventions on the quality of the mother–preterm infant relationship and on the preterm infant's behavior and self-regulation (Feijo, Hernandez-Reif, Field, Burns, Valley-Gray, & Simco, 2006; Feldman, Feller, Sirota, & Eidelman, 2002; Goldstein-Ferber, Feldman, Kohelet et al., 2002). Goldstein-Ferber et al. (2002) showed that mothers whose preterm infants were massaged during the NICU period were less intrusive and that in these cases mother–preterm infant interactions were more reciprocal. Furthermore, the infants who were massaged were more socially involved compared to control infants (Ferber et al., 2002). Feldman et al. (2002) showed that families who had carried out Kangaroo Care during the neonatal care period were more sensitive and less intrusive and that these infants showed less negative affect compared to families who did not carry out Kangaroo Care. Furthermore, Feijo et al. (2006) indicated that the mothers' depressed mood and anxiety levels were reduced after massaging their preterm infants. There are no studies about the parents' holding behavior in home environments after the NICU period and how this holding behavior might be related to the quality of mother–infant interaction.

### 2.3.4 Psychological well-being in mothers of preterm infants

Preterm birth is a psychologically distressing situation for the mothers of preterm infants. Mothers of both high-risk and low-risk preterm infants have been shown to have more characteristics of depression, anxiety and stress than mothers of full term infants during the first three months of the infant's life (Booten, Gennaro & Brown, 1988; Davis, Edwards, Mohay & Wollin, 2003; Singer, Salvator, Guo et al., 1999; Padovani, Carvalho, Duarte & Martinez, 2009). Furthermore, Singer et al. (1999) showed that mothers of high-risk preterm infants continued to report more symptoms of depression, anxiety and stress at 2 years of the infant's age than mothers of full term infants and mothers of low-risk preterm infants. Singer et al. (1999) indicated that the impact of preterm birth on maternal psychological well-being varies with child medical risk status, age, and developmental outcome. Davis et al. (2003) reported that 40% of mothers reported significant depressive symptoms at one month after preterm delivery. High maternal stress was related with depressive

symptoms (Davis et al., 2003). In addition, higher levels of maternal education and increased perception of support from nursing staff decreased the amount of depressive symptoms (Davis et al., 2003). In contrast to the Davis et al. study (2003), Booten, Gennaro, Brown et al. (1988) did not find a correlation between maternal depression and a low socioeconomic status and level of maternal education in a preterm population. Brooten et al. (1988) also indicated that mothers of preterm infants clearly exhibited less depression and anxiety at nine months after the infant's birth than at the time of preterm infant's discharge.

Reduced maternal psychological well-being, as manifested by, for instance depression, anxiety and/or stress, has been shown to be a significant risk factor for the infant's development and the quality of the mother–infant relationship. Maternal stress appears to have a major impact on the mother's intrapersonal feelings and satisfaction (Brown, Bhrolcham, & Hams, 1975). Therefore, maternal stress and anxiety have been suggested as having a negative impact on the mother's ability to recognize and respond to her infant's needs and cues (Crnic et al., 1983). Depressed mothers have been reported to be more negative and less sensitive in mother–infant interaction situations, showing more flat and tense expressions than non-depressed mothers (Field, 1984; Cooper, Tomlinson, Swartz, Woolgar, Murray & Molteno, 1999; Murray, Fiori-Cowley, Hooper, & Cooper, 1996). In addition, infants of depressed mothers are characterized as showing more anger and less affective sharing in free-play situations with their mothers (Stein, Gath, Bucher, Bond, Day, & Cooper, 1991) and to be more insecurely attached to their mothers (Murray, 1992) than infants of non-depressed mothers. Studies have also found that children whose mothers have experienced depression during the infant's first year have more behavioral problems and lower cognitive performance (Murray, 1992; Sharp, Hay, Pawlby, Schmucher, Allen, & Kumar, 1995).

In preterm infants, maternal stress and anxiety have been shown to be related to the quality of the mother–infant relationship. Muller-Nix et al. (2003) indicated that mothers who were highly stressed in the perinatal period were found to be less sensitive and more controlling in a dyadic interaction at 6 months of the infant's age than mothers of full term infants and less-stressed mothers of preterm infants. In addition, at 18 months of age, interactional behavior in preterm infants of highly stressed mothers appeared to be different, showing less passivity and more compulsive-compliance behavior, from that of full term infants or preterm infants of less-stressed mothers (Forcada-Guex et al., 2005; Muller-Nix et al., 2003).

Wijnroks (1999) proposed that a mother's recollected anxiety was related to the quality of mother–infant interaction at 6 months of infant's age suggesting that maternal anxiety may partly explain why mothers of preterm infants have been frequently found to be more active and stimulating during interaction with their infants than mothers of full term infants. Anxiety was defined as feelings

and concerns surrounding their infants' preterm birth and hospitalization. The impact of maternal anxiety on mother–infant interaction was not related to the infant's medical history, current interactive behavior, or developmental status (Wijnroks, 1999). Zelkowitz, Papageorgiou, Bardin, & Wang (2009) showed that maternal anxiety during NICU period was associated with less sensitivity and less structure in maternal interaction behavior still at 24 months of pretem child's age. In addition, preterm children of mothers with higher anxiety scores were less likely to involve their mothers in their play at 24 months corrected age (Zelkowitz et al., 2009).

As a conclusion, maternal stress and anxiety clearly seem to negatively affect the mother–preterm infant relationship. As far as we know, the relation between maternal depression and the quality of the mother–preterm infant relationship has not been studied in preterm populations. This would be an important subject for study, as we know that mothers of preterm infants are at a higher risk for maternal depression (Singer, Salvator, Guo et al., 1999; Davis, Edwards, Mohay & Wollin, 2003) and that depression may have long-lasting effects on the mother–infant relationship and the infant's development (Murray et al., 1996; Murray, 1992).

## 2.3.5 Socioeconomic background and family structure

Socioeconomic status and family structure are associated with the quality of the mother–infant relationship and the infant's development (Conger & Donnellan, 2007; Belsky, Bell, Bradley, Stallard & Stewart-Brown, 2007). Actually, it has been suggested that the social class of the family is the best predictor of the infant's mental health (Aber, Jone, & Cohen, 2000). The parents' lower level of education and poverty may decrease the amount and the quality of learning stimulation in the infant's environment and thus affect the infant's welfare (Aber et al., 2000). Above all, low socioeconomic status and poverty increase parental stress, which decreases parental sensitivity in interaction and caregiving situations (Abler et al., 2000; Conger & Donnellan, 2007; Crnic, Greenberg, Ragozin, Robinson, & Bashman, 1983).

In studies of preterm infants, low socioeconomic status has been related to parental stress, to the quality of mother–infant interaction and to the prematurity itself. The socioeconomic level has been shown to be lower in highly stressed mothers of preterm infants than in less-stressed mothers of preterm infants or mothers of full term infants (Muller-Nix et al., 2003). In addition, in the data from Borghini et al.'s (2006) study, the socioeconomic status was lower in a group of high-risk preterm infants than in groups of low-risk preterm infants and full term infants. The low socioeconomic status and level of education may represent confounding variables in these studies. Furthermore, Gerner's study (1999) showed that mothers with a lower education level had a lower quality of dyadic interaction in a preterm population. It has been considered (Gerner, 1991; Muller-Nix et al., 2004;

Wille, 1991) that the quality of the mother–infant relationship may be biased in many studies by risk factors other than preterm birth itself. Therefore, more studies where socioeconomic background is controlled for are needed.

The family structure also has an influence on the quality of the mother–infant relationship and the infant's development. Single parenthood and a blended family structure increase the risk for problems in the parent–infant relationship and in the infant's development (Kaplan & Pruett, 2000; Seltzer, 1994). In addition, the infant's birth order has been shown to have an affect on the mother-infant relationship especially in preterm population (Cohen & Beckwith, 1977; Bendersky & Lewis, 1986). The results have indicated that firstborn preterm infants receive more social attentiveness and more responsiveness from their mothers than later born preterm infants.  It has been suggested that this is caused by the greater quantity of social interaction with the mother that the firstborn infant experiences compared to later-born children, who must share the mother's attention with siblings (Cohen & Beckwith, 1977). Based on these findings, we suggest that the family structure and the infant's birth order should also be taken into account in future studies of the preterm infant–mother relationship.

# 3   AIMS OF THE STUDY

The aims of the study were:

1.)   to study if prematurity affects the mother's, the infant's or dyadic affect and behavior in free-play mother–infant interaction situations at 6 and 12 months of corrected age (Study I).

2.)   to study if prematurity affects maternal attachment representations at 12 months of infant's corrected age (Study II).

3.)   to assess how maternal attachment representations are related to the quality of mother–infant interaction in preterm and full term infant–mother pairs (Study IV).

4.)   to explore the protective and the risk factors affecting the mother–preterm infant relationship.

More specifically, to study

4.1.   how the infant's crying and the parent's holding behavior are related to the quality of mother–infant interaction in preterm and full term infant–mother pairs (Study I).

4.2.   how maternal depression is related to the quality of mother-infant interaction (Study II) and maternal attachment representations (Study III) in preterm infant-mother pairs.

4.4.   how the infant's medical and family background factors are related to the mother-infant interaction, maternal attachment representations, maternal depression, infant's crying and caregiver's holding in a preterm population (Studies I, II and III).

# 4    MATERIALS AND METHODS

## 4.1   Study design

The present study is a part of the PIPARI study, which is a multidisciplinary prospective long-term follow-up study of preterm infants. The PIPARI study population consists of a cohort of 232 very preterm infants (birth weight < 1501 g or gestational age < 32 weeks) born at Turku University Hospital during the years 2001-2006 who survived. The exclusion criteria were: 1) infants whose caregiver was not able to follow the study protocol in Finnish or in Swedish and 2) the family living outside the hospital's catchment area.

The quality of the mother–infant relationship was studied in detail using a subsample of preterm infants selected from the PIPARI study population. A control group for this mother–infant relationship study was formed.

This substudy on mother–infant relationships was approved by the Ethical Committee of the Hospital District of South-West Finland in September 2001.

## 4.2   Study subjects

The inclusion criteria for the mother–infant relationship study group were 1) native Finnish mother, 2) mother's first child, 3) singleton infant and 4) no recognized fetal drug or alcohol exposures. Those preterm infants who were born from multiple pregnancies where other sibling did not survive were included to this study. All preterm infant–mother pairs (n=49) in the PIPARI study population born between 2001 and 2005 that met these inclusion criteria were invited to participate in the study. Two families refused to participate, and three families withdrew from the study because of moving outside the catchment area before 5 months of the infant's corrected age. In addition, two families withdrew from the study because of stressful life situations before the assessment at 12 months of corrected age. The mother–preterm infant relationship study group included 44 preterm infants at 5 months of corrected age and 42 preterm infants at 12 months of corrected age. Those preterm infants who were born from multiple pregnancies where the other sibling did not survive were excluded (n=4) from the data in studies III and IV.

In the mother–infant relationship study, the control group consisted of healthy full term infants (i.e. born at 37 gestational week) who were firstborns and singletons and born to Finnish-speaking mothers. Furthermore, the inclusion criteria were 1) birth weight less than –2.0 standard deviation below the mean of Finnish growth charts (mean 3589 g, SD 406) and 2) no admissions to neonatal care. Parents and their healthy, full term infants born between

October 2001 and June 2002 at Turku University Hospital and who met the inclusion criteria were invited to participate in the study two days after the birth. Forty-nine out of 80 (61%) informed families agreed to participate in the study. In the control group, two families withdrew from the study before the infant was 5 months of corrected age. In addition, two families withdrew from the study before the infant was 12 months of corrected age. The final control group included 47 full term infants at 6 months of corrected age and 45 preterm infants at 12 months of corrected age. The age at the assessment point was calculated based on the expected day of delivery, also in the group of full term infants.

Study I consisted of 32 preterm infant–mother pairs, including those infants from the mother–infant relationship study population who were born between 2001 and June 2004. The control group included those full term infants (n=36) who were born between October 2001 and April 2002.

Study II consisted of 111 preterm infants and their mothers from the PIPARI study population and 32 preterm infant–mother pairs from the PIPARI mother–infant relationship substudy. Preterm infants in both populations were born between October 2001 and April 2004. This study did not include a control group, as there were no mothers with a high number of depression symptoms (>12) in the group of full term infants.

Studies III–IV consisted of 38 preterm infant–mother pairs from the mother–infant relationship study population born between October 2001 and October 2005. Those preterm infants who were born from multiple pregnancies where the other sibling did not survive were excluded from this data. The control group in studies III and IV included those control infants (45) who were born between October 2001 and June 2002.

Sample characteristics from Studies I–IV are shown in Table 1.

**Table 1.** Summary of sample characteristics in Studies I-IV

| Variable | Study I | | Study II | Study III-IV | |
| --- | --- | --- | --- | --- | --- |
| | Full terms (n=36) Mean(SD) Median* N(%) | Preterms (n=32) Mean(SD) Median* N(%) | Preterms (n=111) Mean(SD) Median* N(%) | Preterms (n=38) Mean(SD) Median* N(%) | Full terms (n=45) Mean(SD) Median* N(%) |
| *Infant characteristics* | | | | | |
| Birth weight (grams) | 3589 (496) | 1008 (289) | 1066 (300) | 1090 (34) | 3060 (366) |
| GA (weeks) | 40 (1) | 28 (3) | 28 (3) | 28 (3) | 40 (1) |
| Apgar ( 5 min) | 9* | 7* | 7* | 7* | 9* |
| Days in hospital | - | 74(45) | 57.8 (30) | 71 (46) | - |
| Days in respiratory treatment | - | 14(0.20) | 10 (0.40) | - | - |
| Female (n) | 17 (47%) | 13(43%) | 50 (45%) | 17 (45%) | 22 (49%) |
| *Parental characteristics* | | | | | |
| Mother's age | 28.5 (4.6) | 28.8 (5.1) | 29.9 (5.2) | 28.3 (5.1) | 28.2 (4.8) |
| Father's age | 30.3 (5.1) | 29.7 (6.0) | 32.0 (6.4) | 30.1 (5.7) | 30.3 (5.2) |
| Previous maternal mental health problems (n) | - | 3 (9.4%) | 15 (15%) | 4 (11%) | 7 (15%) |
| Mother's education (n) | | | | | |
| - 12 years or more | 26 (74%) | 22 (73%) | 56 (59%) | 24 (63%) | 33 (74%) |
| - 9-12 years | 9 (26%) | 8 (27%) | 39 (41%) | 14 (37%)% | 12 (26%) |
| - under 9 years | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Father's education (n) | | | | | |
| - 12 years or more | 15 (44%) | 13 (46%) | 28 (25%) | 15 (43%) | 26 (58%) |
| - 9-12 years | 19 (56%) | 14 (50%) | 58 (52%) | 19 (54%) | 19 (41%) |
| - under 9 years | 0 (0%) | 1 (4%) | 7 (6%) | 1 (0.01%) | 0 (0%) |
| Nuclear family (n) | 34 (94%) | 29 (97%) | 98 (88%) | 36 (95%) | 44 (98%) |
| Single parent (n) | 2 (6%) | 1 (3%) | 2 (2%) | 2 (5%) | 1 (2%) |

*n=number, SD= standard deviation*

## 4.3  Study protocol and procedure

Families were informed about the study protocol in the neonatal intensive care unit (NICU) (preterm infants) and at the newborn nursery (full term infants). Parental consent was obtained after oral and written information was provided. The protocol in the mother–infant relationship study included three assessment points (5, 6 and 12 months of the infant's corrected age) in the groups of preterm infants and full term infants. Four assessment measures were used: 1) the Baby Day Diary at 5 months of the infant's corrected age to evaluate the infant's crying and the caregiver's soothing behavior, 2) the Edinburgh Postnatal Depression Scale (EPDS) at 6 months of the infant's corrected age to assess symptoms of maternal depression, 3) the Parent–Child Early Relational Assessment (PCERA) method at 6 and 12 months of corrected age to assess mother–infant interaction and 4) the Working Model of the Child Interview (WMCI) at 12 months of corrected age to evaluate maternal attachment representations. The measures used in the different studies are shown in Table 2.

**Table 2**. Summary of the measures used in Studies I-IV

|  | Study I | Study II | Study III | Study IV |
|---|---|---|---|---|
| 5 months * | Baby Day Diary |  |  |  |
| 6 months * | PCERA | PCERA + EPDS | EPDS | PCERA |
| 12 months * | PCERA | PCERA | WMCI | PCERA + WMCI |

*corrected age

In addition, medical variables of the infants and the parents' background factors were collected during the NICU period (preterm infants) and when the infant was 12 months old (both groups). Those infant medical and family background factors that are crucial to the study variables are shown in Table 1. There were no differences between the groups of preterm and full term infants in terms of family background factors, including mother's and father's age, education and family strucuture.

A physician gave instructions on filling in the Baby Day Diary to the parents during neonatal care. A reminder was given by telephone two weeks before the assessment point. For the families of full term infants, a psychologist gave the instructions for the diary at home two weeks before the five-month assessment point. The parents kept Baby Day Diaries for three days when the infant was at 5 months of corrected age. The parents were asked to complete the diary during a normal day without acute illnesses or any recent vaccinations. For one preterm infant hospitalized at 5 months of corrected age, a nurse completed the diary when the parents were not present. All diaries were completed and returned (n=42 preterm / 45 full term). Three of the 198 (1.5%) diary days were excluded from the analysis because of a febrile illness or a vaccination day.

The Edinburgh Postnatal Depression Scale (EPDS) questionnaire was sent to all mothers of preterm infants in the PIPARI study population born between 2001 and 2004 (n=125), including members of the interaction study group (n=32), at 6 months of the infant's corrected age. Of the preterm infants' mothers, 113 returned the questionnaire. All mothers of preterm infants participating in the mother–infant relationship study returned the questionnaire. Two mothers of preterm infants failed to complete the questionnaire and, therefore, were excluded from the data analysis. Finally, 111 EPDS scores of mothers of preterm infants could be analyzed.

Mother–infant interaction was videorecorded in a free-play situation at 6 and 12 months of corrected age. The interaction situation was recorded in a room at a private pediatric clinic, and a speech therapist or a psychologist instructed the parents about the procedure. For the videorecording, the mother and the infant were placed on a soft mat with age-appropriate toys. Instructions given to the mother prior to the videorecording were: "This is a free-play time with your infant. You can use the toys, or you can play without the toys. Try to play as you are used to playing with your infant at home." Videorecordings were obtained for all mother–infant pairs (n=42 preterm / 45 full term). For one preterm infant hospitalized at 6 months of corrected age, the videorecording was carried out in the hospital.

The Working Model of the Child Interviews were conducted either at a private pediatric clinic or at the child's home at 12 months of infant's corrected age. The infants were not present during the interviews. One psychologist (R.K.) interviewed all mothers (n=42 preterm / 45 full term). Interviews were obtained from all mother–infant pairs.

## 4.4 Instruments

*Parent–Child Early Relational Assessment method.* The five-minute-long period of mother–infant interaction in the free-play situation was analyzed using the Parent–Child Early Relational Assessment (PCERA) method (Clark, 1985). The PCERA assessment consists of 29 parental items, 25 infant items, and 8 dyadic items, which are presented in the Appendix. All items are rated on a 5-point Likert scale. Scores of 1 and 2 describe an area of concern, a score of 3 describes an area of some concern, and scores of 4 and 5 describe an area of strength. Three trained coders who were unaware of the infant's background and clinical status carried out the assessment. To estimate the inter-rater reliability from the study data, 20% of all assessments were double-scored. In addition, every tenth assessment was coded in a drift session supervised by a Finnish PCERA trainer. Before the inter-rater agreement calculation and all data analyses, the items were re-coded into a 3-point scale: 1 and 2 were combined into 1, 3 became 2, and 4 and 5 were combined into 3. The inter-rater reliability from the study data was assessed by calculating the

mean of the agreement percentile of the raters' overall agreement. Three items (maternal positive physical contact, infant's positive affect, and dyadic reciprocity) from the 6-month assessment and five items (maternal expressed positive affect, maternal mirroring, infant's positive affect, infant's social response, dyadic enthusiasm) from the 12-month assessment were excluded from the data analysis because of inter-rater reliability under 0.55. After these items were excluded, the mean of inter-rater agreement was 0.82 at both age points.

Before data analysis of the PCERA items, nine scales were formed, according to Clark's model (1999): 1) maternal positive affective involvement, 2) maternal negative affect and behavior, 3) maternal positive communication, 4) infant's positive affect, 5) infant's sober and withdrawn mood, 6) Infant's quality of play and attention skills, 7) dyadic mutuality, 8) dyadic disorganization and tension and 9) dyadic flatness. High PCERA scores always indicate positive affect and behavior. High scores on scales 2, 5, 8 and 9 indicate a lack of negative affect and behavior. The internal consistency of the subscales was calculated as Cronbach's alphas. The PCERA items, scales and Cronbach's alphas are shown in the Appendix.

In addition, the numbers of areas of concern from parental, infant and dyadic items were counted by combining scores 1 and 2 (on a 3-point scale) as a concern variable. The range of concern areas was, in the parental concern variable, 0-15 in the group of preterm infants and 0-17 in the group of full term infants; in the infant concern variable, 1-14 in the group of preterm infants and 0-16 in the group of full term infants; and, in the dyadic concern variable, 0-7 in the group of preterm infants and 0-6 in the group of full term infants.

*The Working Model of the Child Interview.* The mothers' representations of their infants were studied using the Working Model of the Child Interview (WMCI) (Zeanah, Benoit, Hirschberg, Barton, & Regan, 1994) at 12 months of the infant's corrected age. This one-hour semi-structured interview has been developed to evaluate a parent's perceptions and subjective experience of her infant's individual characteristics and her relationship to the infant. The interview includes questions about the pregnancy, the delivery, the infant's development, the infant's personality and behavior and the parent's relationship with her infant.

The coding process included two phases (Zeanah, Benoit, Barton, & Hirshberg, 1996). At first, representations were coded using 8 5-point qualitative scales. The qualitative scales were 1) richness of perceptions, 2) openness to change, 3) intensity of involvement, 4) coherence, 5) caregiving sensitivity and 6) acceptance, 7) infant difficulty and 8) fear for infant's safety. After this rating, the mother's representations were classified into one of three main categories: balanced, disengaged or distorted. The balanced category was characterized by high scores in the qualitative scales, while the

disengaged and distorted classifications were characterized by lower scores in the qualitative scales. In addition, disengaged representation is characterized by various degrees of emotional distance, and distorted representation is characterized by confusion, anxiety and distortion.

Three coders analyzed the videorecorded interviews. These coders were different from those who coded the PCERA situations. All three coders participated in a five-day WMCI coding training held by Charles Zeanah and Anna Smyke at Tulane University during the summer of 2002. After the training, the main coder did a WMCI training reliability test. The percentage of agreement from the training reliability tapes (n=20) was 80%. The main coder analyzed all interviews. Additionally, to estimate the inter-rater reliability from the study data, 30% of all assessments were double-scored. Inter-rater reliability was assessed by calculating the proportion of overall agreement. Inter-rater agreement regarding the three main classifications was .90 (kappa=.83). Three qualitative scales (richness of perceptions, openness to change, intensity of involvement) had inter-rater agreement of under .65. Therefore, these three qualitative scales were excluded from the data analysis. The inter-rater agreements for the other five qualitative scales were .65 (coherence), .68 (sensitivity) and .80 (acceptance, fear for infant's safety and infant's difficulty). These five qualitative scales and the three main representation categories were used in the data analysis.

*Baby Day Diary.* The infant's crying and the caregiver's holding behaviors were recorded using a parental diary called the Baby Day Diary, which is a validated method for studying the infant's fussing and crying (Barr, 1988). The diary consisted of five categories describing infant behavior: 1) fussing, 2) crying, 3) sleeping, 4) awake content and 5) feeding. In the data analysis, the negative behaviors, e.g. crying and fussing, were combined into a single variable. The combined crying and fussing behavior was assessed by two separate parameters: the duration and the frequency of crying. In the following context, the combined fussing and crying variables are called the frequency or the duration of crying variable. Three categories described the caregiver's soothing behavior: holding, caretaking, and moving around with the infant. Holding was defined as carrying the infant in one's arms or having the infant on one's lap (whether the infant was crying or not). In the analysis, the duration and the frequency of the infant's behaviors (fussing, crying, awake content, sleeping and feeding), and the caregiver's behaviors (moving, holding, and caretaking) were calculated as a mean for a day. The amount of holding was studied separately from the amount of caregiving and moving around outside the home.

*Edinburgh Postnatal Depression Scale (EPDS).* The features of maternal depression were studied using the Edinburgh Postnatal Depression Scale (Cox, 1994; Cox, Holden & Sagovsky, 1987). EPDS is a self-report questionnaire including 10 items. It is a well-validated and widely used method

designed especially to screen for postnatal depression. Each item is rated on a 4-point scale (0-3). The sum score of items ranges from 0 to 30. A cut-off score of 13 is used to divide mothers into two groups: those who had clear depressive symptoms (a score of 13 or more) and those who did not have clear depressive symptoms (a score of 12 or under). It has been argued that the cut-off of 13 may not recognize all mothers with clinical depression (Cox et al., 1987). However, the use of a lower cut-off would increase the number of false positive cases. In this study, we used scores of 13 or above to indicate a high number of depressive symptoms and scores of 10 to 12 to indicate a moderate number of depressive symptoms. The aim of the study was to correlate a high number of depressive symptoms to the quality of mother–infant interaction and to maternal representation categories. However, those exhibiting a moderate number of depressive symptoms were also reported, in order to show the whole spectrum/variation of depressive symptoms in Finnish mothers of preterm infants.

## 4.5   Statistical methods

Differences between the study groups according to the PCERA scales, items, concern variables and infant's crying and caregiver's holding variables were analyzed using independent samples t-test. Analyses of mother–infant interaction (PCERA scales) were performed separately at 6 and 12 months of corrected age. The comparison between the study groups in WMCI classification was done using a chi-square test. The differences between the study groups in the qualitative scales of the WMCI were assessed using one-way ANOVA.

To analyse the role of maternal representations in the mother-infant interaction, PCERA factors were used as dependent variables in ANOVAs. Two-way ANOVAs were used to evaluate the interaction of WMCI categories (balanced/distorted/disengaged) and group variable (preterm/full term), followed by one-way ANOVAs with Tukey's HSD as post-hoc test to compare the means. The scale of maternal negative affect and behavior was excluded from this data analyses, as it did not discriminate the study population. The scale of dyadic flatness was excluded, as it strongly correlated with the scale of dyadic mutuality.  Furthermore, the role of maternal representations on the mother-infant interaction was analyzed using the variables of concern from the PCERA. WMCI classification, prematurity and interaction between the two variables were used as predictors of variables of concern using negative binomial regression models.

How holding and the two crying variables (duration and frequency) were associated with mother–infant interaction (PCERA scales) was studied using multiple regression analysis. Regression models were adjusted for the group variable (preterm/full term), SGA (small for gestational age), gender, and

length of ventilator treatment. In addition, models included one of three study variables (the amount of holding, the duration or the frequency of crying) and an interaction parameter between the study variable and the group variable (preterm/full term). The interaction parameter allowed estimation of different effects of the study variables in preterm and full term infants. Regression coefficients of study variables are presented for both groups separately. Similar regression models were also used to study the associations between holding and the two crying variables (the duration and the frequency of crying) and to study associations between the duration of crying and the frequency of crying.

The associations between the symptoms of maternal depression and PCERA scales were studied using mixed model repeated measures analysis. The age point, the EPDS score ($\leq$12/>12) and their interaction were used as predictors. As there were no cases of a high number of depressive symptoms (>12) in the mothers of full term infants, the relation between maternal depression and mother-infant interaction was analyzed only in the group of preterm infants. As the interaction between the age point and the EPDS score was not significant on any response variable, the results are expressed as estimated differences between depressed and non-depressed mothers averaged over two time points and standard errors. Akaike Information Criterion (AIC) was used to select the best covariance structure.

Univariate effect of maternal depression symptoms on the WMCI classifications were analyzed using multinomial logistic regression.The The association between maternal depression and WMCI classification was further studied by fitting a multinomial logistic regression model in which maternal depression and group classification were used as independent variables.

Correlations between the infant's medical variables, holding, crying, and PCERA scales were studied using Pearson's correlation coefficient. Differences between two groups according to the maternal depression EDPS score were analysed using a Mann-Whitney U test. The correlation between postnatal depression and continuous background factors was calculated using Spearman's correlation coefficient. The effect of continuous background factors on the WMCI classifications was analyzed using multinomial logistic regression. The relations between categorical background factors and WMCI classifications were analyzed using Fisher's exact test, because the expected cell frequencies were less than five.

Statistical analyses were performed using SAS (version 9.1; SAS Institute, Cary, NC) and SPSS for Windows (11.0, SPSS Inc., 13.0, SPSS Inc., 16.0, SPSS Inc). Differences were considered statistically significant if the p-value was 0.05 or below. P-values below 0.10 were reported and values over 0.10 were reported using NS (non significant).

# 5 RESULTS

## 5.1 Prematurity and mother–infant interaction

The results regarding the quality of mother-infant interaction at 6 months of corrected age showed no significant differences between the groups of preterm and full term infants in any of the nine PCERA scales (Table 3). At 12 months of corrected age, there were significant differences in two PCERA scales: preterm infants had lower quality of play and attention skills (t=-2.7, p=.01), and they had a more sober and withdrawn mood (t=-2.0, p=.05). In one of the nine PCERA scales (maternal negative affect and behavior), only a few scores were below the optimal score and, therefore, it did not discriminate the study population at either age point. Comparisons and test values are shown in Table 3.

The second comparison between groups was done using the concern variables indicating the number of scores of concern in PCERA items. No significant differences were found between preterm and full term infants in the number of scores of concern in the parental [M(SD)=9.3 (4.59), M(SD)= 8.8(5.56), t=0.47, NS, respectively], infant [M(SD)= 7.0(3.8), M(SD)=6.1(4.3), t=8.3, NS, respectively], or dyadic [M(SD)=2.7 (1.5) and M(SD)=2.7 (2.0), t=0.0, NS, respectively] variables at 6 months of corrected age. In addition, no differences were found between preterm and full term infants in the number of scores of concern in the parental [M(SD)=2.6(3.5), MD(SD)=1.9(2.7), t=0.94, NS], infant [M(SD)=2.1.(2.6); M(SD)=1.3(1.7), t=1.08, NS] or dyadic [M(SD)=8.33(1.29), M(SD)=5.33(1), t=1.4, NS, respectively] variables at 12 months of corrected age.

**Table 3.** PCERA scales of preterm and full term infants and their mothers at 6 and 12 months of corrected age.

| PCERA factors | Preterm infants 6 months (n=30) | | Preterm infants 12 months (n=28) | | Full term infants 6 months (n=36) | | Full term infants 12 months (n=34) | | t 6 Mo | p 6 Mo | t 12 Mo | p 12 Mo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mean | SD | mean | SD | mean | SD | mean | SD | | | | |
| 1. Maternal positive affective involvement | 2.35 | 0.4 | 2.23 | 0.6 | 2.43 | 0.5 | 2.39 | 0.4 | -0.7 | NS | -1.4 | NS |
| 2. Maternal negative affect and behavior | 2.98 | 0.1 | 2.91 | 0.3 | 2.99 | 0.0 | 2.99 | 0.0 | -1.0 | NS | -1.8 | .08 |
| 3. Maternal positive communication | 2.35 | 0.4 | 2.50 | 0.5 | 2.28 | 0.5 | 2.57 | 0.4 | 0.6 | NS | -0.6 | NS |
| 4. Infant's positive affect | 2.30 | 0.6 | 2.38 | 0.6 | 2.44 | 0.5 | 2.59 | 0.5 | -1.1 | NS | -1.5 | NS |
| 5. Infant's sober & withdrawn mood | **2.33** | **0.4** | **2.31** | **0.4** | **2.32** | **0.4** | **2.52** | **0.4** | **0.0** | **NS** | **-2.0** | **.05** |
| 6. Infant's quality of play, interest & attention | **2.49** | **0.3** | **2.44** | **0.4** | **2.53** | **0.3** | **2.67** | **0.3** | **-0.7** | **NS** | **-2.7** | **.01** |
| 7. Dyadic mutuality | 2.22 | 0.5 | 2.38 | 0.5 | 2.26 | 0.6 | 2.52 | 0.4 | -0.3 | NS | -1.2 | NS |
| 8. Dyadic disorganization and tension | 2.54 | 0.3 | 2.70 | 0.4 | 2.49 | 0.4 | 2.77 | 0.3 | 0.5 | NS | -0.9 | NS |
| 9. Dyadic flatness | 2.21 | 0.5 | 2.31 | 0.6 | 2.27 | 0.6 | 2.50 | 0.5 | -0.4 | NS | -1.3 | NS |

*n=number, statistically significant results are in bold.*

## 5.2 Prematurity and maternal attachment representations

There were no differences between mothers of preterm infants and mothers of full term infants in the distribution of the three main representation categories (balanced, disengaged and distorted; $\chi^2$=2.42, df=2, NS). In the preterm group, 55% of the mothers (n=21), and in the full term group, 69% of mothers (n=31) had balanced representations. In the preterm group, 18% of mothers (n=7) had disengaged representations and 26% of mothers (n=10) had distorted representations. In the full term group, 18% of mothers (n=8) had disengaged representations and 13% of mothers (n=6) had distorted representations.

Group differences were found in three of five qualitative WMCI scales. The mothers of preterm infants showed statistically poorer scores in three of five scales; they had less coherence [M(SD)=3.37(0.73), M(SD)=3.62(0.83), F(1,69)=4.0, p=0.048] and acceptance [M(SD)=3.34(0.67), M(SD)=3.84(0.71), F(1,69)=10.9, p=0.010] and more fear for the infant's safety [M(SD)=1.6(0.9), M(SD)=1.0(0.16), (F(1,69)=14.44, p<0.001] in their representations than mothers of full term infants. In addition, there was a similar trend, although not statistically significant, in the sensitivity scale [M(SD)=3.19(0.81, M(SD)=3.51(0.66), F(1,69)=3.9, p=0.051] No differences were found between groups in the scale of infant's difficulty [M(SD)=1.3(0.7), M(SD)=1.2(0.46), F(1,69)=0.87, NS].

## 5.3 Maternal attachment representations and the mother–infant interaction

The WMCI representation categories were related to six of seven PCERA scales (Table 4) at both age points. The associations were always in the expected direction, i.e. unbalanced representations were associated with the lower quality of interaction. The means, standard deviation and group comparisons are shown in Table 4. At 6 months of corrected age, the scales of maternal positive affective involvement, infant's positive affect, infant's sober and withdrawn mood, infant's quality of play and attention skills, dyadic mutuality and dyadic disorganization and tension related significantly to the WMCI representation categories. At 12 months of corrected age, the scales of maternal positive affective involvement, maternal positive communication, infant's sober and withdrawn mood, infant's quality of play and attention skills, dyadic mutuality and dyadic disorganization and tension related significantly to the WMCI classifications. Preterm birth did not affect this relation. There was no statistical interaction between preterm birth and WMCI category in any of the PCERA scales.

The effects of WMCI classification and prematurity on mother–infant interaction were also analyzed using PCERA variables of concern. These associations are demonstrated in Figures 2,3 and 4. The number of scores of concern in dyadic

variables was significantly higher in mothers with distorted representations (at 6 months: $\chi^2$=7.62, p=0.006; at 12 months: $\chi^2$=4.94, p=0.02) and disengaged representations (at 6 months: $\chi^2$=3.48, p=06; at 12 months: $\chi^{2=}$4.04, p=0.04) compared to mothers with balanced classifications, both in preterm and full term populations. There were no statistically significant differences in the amount of concern scores in the parental (at 6 months: $\chi^2$=3.14, p=0.20; at 12 months:$\chi^2$=5.50, p=0.06) or in the infant (at 6 months: $\chi^2$=2.30, p=0.15; at 12 months: $\chi^2$=4.54, p=0.10) variables between mothers with balanced, disengaged or distorted representations.

The analyses show that the distorted representation classification was more strongly related to non-optimal mother–infant interaction than was disengaged classification (Table 4.). The mothers with distorted representations differed from the mothers with balanced representations in five out of seven scales at both age points.  At 6 months of corrected age, these scales were infant's positive affect (p=0.013), infant's sober and withdrawn mood (p=0.005), infant's quality of play and attention skills (p=0.009), dyadic mutuality (0.005) and dyadic disorganization and tension (0.004) At 12 months of corrected age, the scales were maternal positive affective involvement (p=0.004), maternal positive communication (p=0.016), infant's sober and withdrawn mood (p=0.029), dyadic mutuality (p=0.005) and dyadic disorganization and tension (p=0.001). The mothers with disengaged representations and their infants differed significantly from the mothers with balanced representations and their infants at 6 months of age in the scale of maternal positive affective involvement (p=0.017) and at 12 months in the scales of maternal positive communication (p=0.027), infant's sober and withdrawn mood (p=0.029) and infant's quality of play and attention skills (p=0.005).

**Table 4.**

N=83
(38 preterm+45 full term infants)

WMCI-classification

| PCERA scales | | Balanced Mean | SD | Distorted Mean | SD | Disengaged Mean | SD | $F^1$ | $F^2$ |
|---|---|---|---|---|---|---|---|---|---|
| 1. Maternal positive affective involvement | 6 months | **3.64** | **0.58** | **3.50** | **0.44** | **3.20** | **0.34** | **4.01*** | 0.05 |
| | 12 months | **3.58** | **0.60** | **2.96** | **0.47** | **3.16** | **0.70** | **6.84**** | 0.05 |
| 2. Maternal positive communication | 6 months | 3.60 | 0.69 | 3.38 | 0.50 | 3.25 | 0.42 | 2.11 | 0.04 |
| | 12 months | **3.86** | **0.65** | **3.27** | **0.73** | **3.33** | **0.63** | **6.20**** | 0.01 |
| 3. Infant's positive affect | 6 months | **3.67** | **0.72** | **3.03** | **0.95** | **3.44** | **0.72** | **4.3*** | 0.73 |
| | 12 months | 3.66 | 0.83 | 3.37 | 0.86 | 3.39 | 1.01 | 0.92 | 0.48 |
| 4. Infant's sober, withdrawn mood | 6 months | **3.64** | **0.56** | **3.09** | **0.70** | **3.43** | **0.57** | **5.38**** | 0.20 |
| | 12 months | **3.77** | **0.60** | **3.39** | **0.63** | **3.27** | **0.70** | **4.37*** | 0.08 |
| 5. Infant's quality of play, interest and attention skills | 6 months | **3.87** | **0.45** | **3.46** | **0.56** | **3.68** | **0.40** | **4.84*** | 0.46 |
| | 12 months | **4.00** | **0.55** | **3.62** | **0.54** | **3.44** | **0.63** | **6.40**** | 0.07 |
| 6. Dyadic mutuality | 6 months | **3.43** | **0.69** | **2.73** | **0.65** | **3.05** | **0.53** | **7.42***** | 0.17 |
| | 12 months | **3.58** | **0.68** | **2.92** | **0.55** | **3.12** | **0.57** | **6.64**** | 0.41 |
| 7. Dyadic disorganization and tension | 6 months | **3.87** | **0.54** | **3.37** | **0.58** | **3.60** | **0.41** | **5.91**** | 0.76 |
| | 12 months | **4.01** | **0.49** | **3.43** | **0.53** | **3.71** | **0.53** | **7.5***** | 1.80 |

*PCERA factors and WMCI categories: Means, standard deviations and group comparisons*
*\*p<.05, \*\*p<.01, \*\*\*p<.001, $F^1$=group comparison between WMCI categories, $F^2$=interaction between preterm birth and WMCI categories, statistically significant results are in bold.*
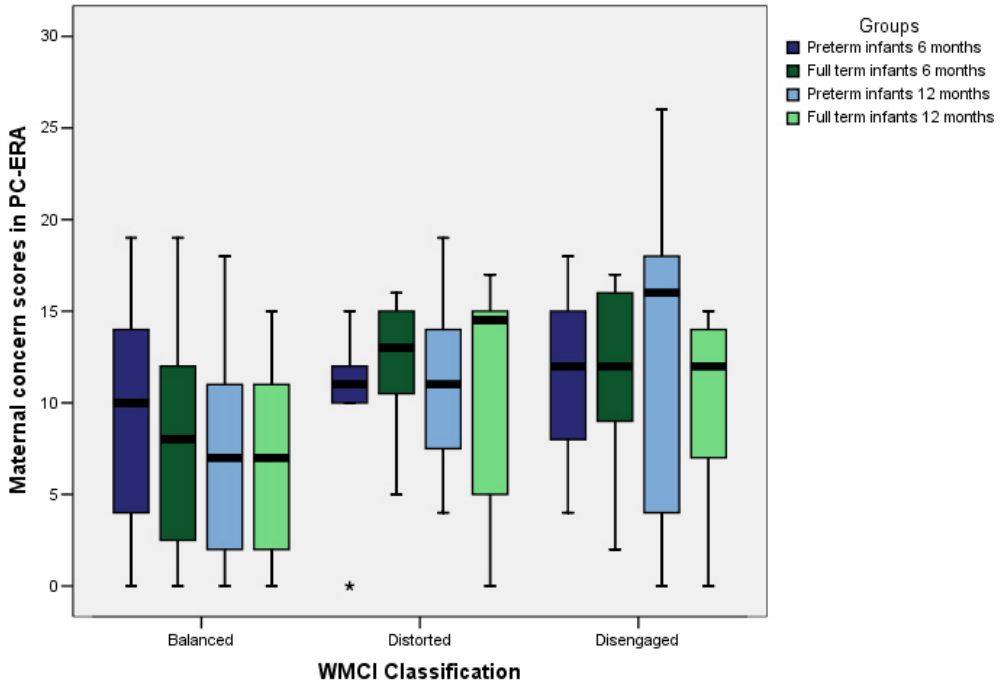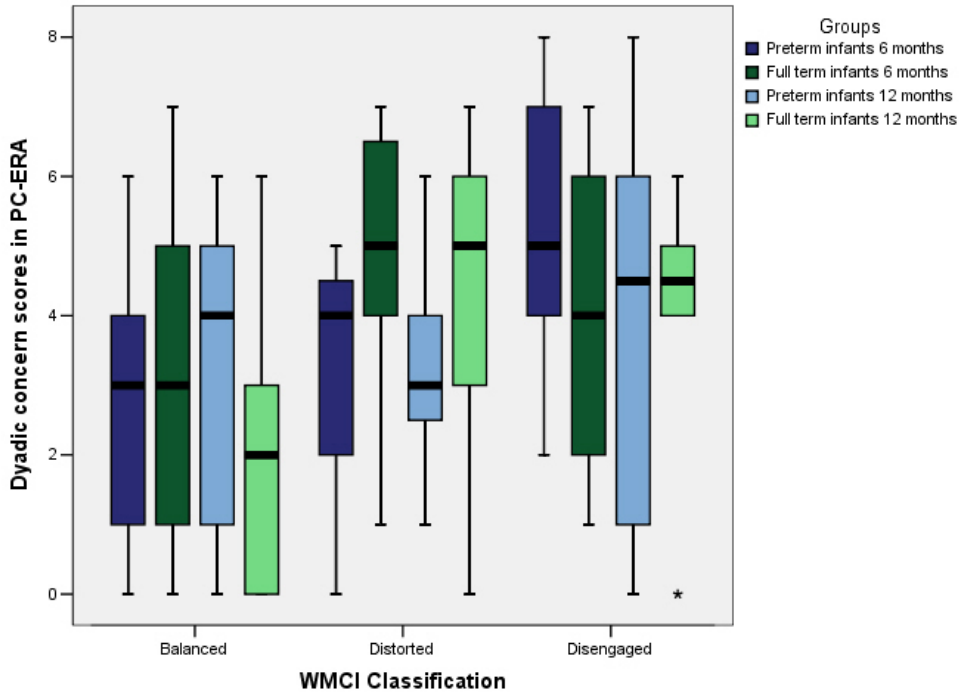
**Figure 2**. Number of scores of concern in maternal PCERA variables and WMCI classification. Medians, quartiles and ranges are shown in the figure.
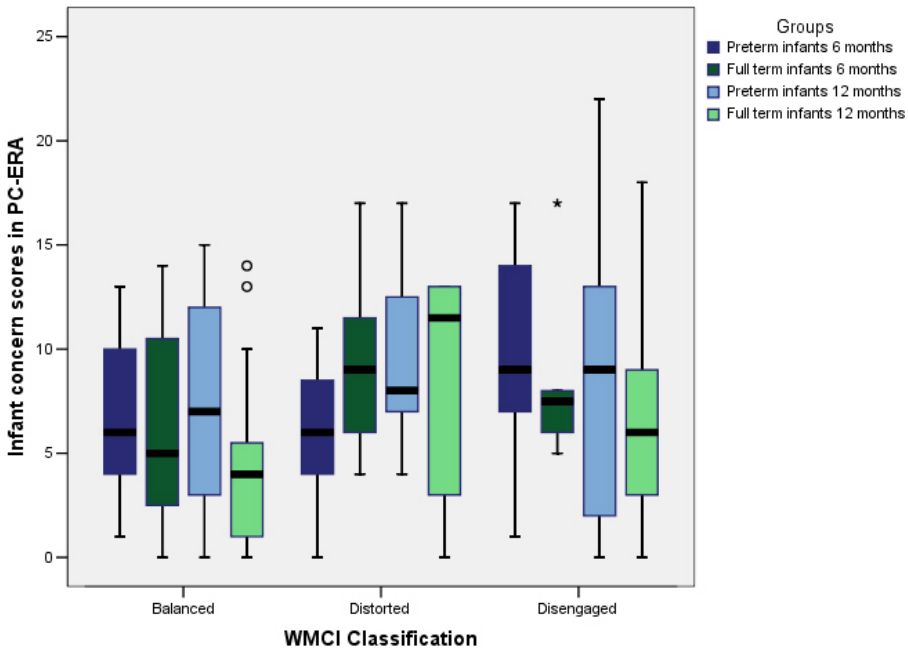


**Figure 3**. Number of scores of concern in infant PCERA variables and WMCI classification. Medians, quartiles and ranges are shown in the figure.

**Figure 4**. Number of scores of concern in dyadic PCERA variables and WMCI classification. Medians, quartiles and ranges are shown in the figure.

## 5.4 Associations between the infant's crying, the caregiver's holding and the mother–infant interaction

Preterm infants had more frequent crying bouts per day than full term infants (M=9.0, SD=6.3 vs M=5.5, SD=3.6, t=2.77, p=0.01). Furthermore, a significant difference was found in the duration of holding, as the preterm infants were held more than the full term infants (M=198.3, SD=101.6 vs M=140.2, SD=65.7, t=2.80, p=0.01). However, there was no significant difference in the duration of crying between preterm (M=82.6, SD=40.1) and full term infants (M=64.9, SD=40.3, t=1.78, p=0.08).

The frequency of crying bouts associated positively with the duration of holding in the group of preterm infants (Table 5a). There was no significant association between the frequency of crying and the duration of holding in the group of full term infants. There was a positive association between the duration of crying and the frequency of crying bouts in the groups of preterm (b=5.01, p=0.000) and full term (b=7.35, p=0.000) infants. The duration of holding did not have a significant effect on duration of crying in either group.

The estimated effect of an increase in holding was positive on every PCERA scale at both age points in the preterm population. The estimates shown in Table 5 describe how a 60-min increase in the duration of holding and crying or a one-bout increase in the frequency of crying affects the PCERA scales after the effects of control variables were adjusted for. A significant association between the duration of holding and the PCERA scales was found with four scales at 6 months of corrected age, and with one scale at 12 months of corrected age in the preterm population. There was more infant's positive affect and dyadic mutuality and less maternal negative affect and dyadic disorganization and tension at 6 months of corrected age in those mother-infant dyads where preterm infants were held more. Furthermore, there was less dyadic disorganization and tension at 12 months of corrected age in those mother-infant dyads where infants were held more. In addition, there were almost significant associations (p<.06) between the duration of holding and dyadic mutuality and between the duration of holding and maternal positive affective involvement at 12 months of corrected age. In the group of full term infants, the duration of holding did not have a significant effect on any of the PCERA scales at 6 or 12 months of corrected age. The duration of crying associated negatively with the scale of maternal positive affective involvement at 12 months of corrected age in the preterm population (p=0.03, b=-0.309). There were no other significant associations between the duration or frequency of crying and the PCERA scales in either group.

**Table 5a.** Estimated effects of holding and crying on PCERA scales based on regression analysis at 6 months of corrected age. Effects are adjusted for the infant's gender, SGA, length of ventilator treatment, and group classification (preterm/full term).

| PCERA scales (1-9) and holding variable | Group | Holding 60 min increase/day | | | Fussing & crying 1 bout increase/day | | | Fussing & crying 60 min increase/day | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | B | SE | P | B | SE | P | B | SE | P |
| **1. Maternal positive affective involvement** | Preterm | .076 | .05 | .14 | .009 | .02 | .55 | -.120 | .14 | .40 |
| | Full term | .019 | .07 | .80 | .013 | .02 | .56 | -.001 | .12 | .96 |
| **2. Maternal negative affect and behavior** | Preterm | **.018** | **.01** | **.01** | .003 | .00 | .12 | .019 | .02 | .31 |
| | Full term | .002 | .01 | .80 | -.000 | .00 | .89 | .003 | .02 | .85 |
| **3. Maternal positive communication** | Preterm | .010 | .05 | .85 | .001 | .02 | .95 | -.086 | .14 | .55 |
| | Full term | -.013 | .07 | .86 | .024 | .02 | .29 | -.019 | .12 | .88 |
| **4. Infant's positive affect** | Preterm | **.123** | **.06** | **.04** | -.002 | .02 | .92 | .044 | .16 | .79 |
| | Full term | .002 | .08 | .98 | .002 | .02 | .93 | -.025 | .14 | .15 |
| **5. Infant's sober and withdrawn mood** | Preterm | .067 | .05 | .15 | -.006 | .01 | .67 | .026 | .13 | .84 |
| | Full term | .029 | .07 | .66 | .010 | .02 | .63 | -.151 | .11 | .17 |
| **6. Infant's quality of play, interest and attention skills** | Preterm | .014 | .03 | .68 | .001 | .01 | .95 | .089 | .09 | .35 |
| | Full term | .041 | .05 | .41 | .015 | .01 | .32 | -.079 | .08 | .33 |
| **7. Dyadic mutuality** | Preterm | **.132** | **.06** | **.04** | .000 | .02 | .96 | -.028 | .18 | .87 |
| | Full term | - | .09 | .71 | .023 | .03 | .41 | -.052 | .15 | .73 |
| **8. Dyadic disorganization and tension** | Preterm | **.082** | **.04** | **.04** | .007 | .01 | .55 | .040 | .11 | .71 |
| | Full term | .016 | .05 | .77 | .017 | .02 | .33 | -.086 | .09 | .36 |
| **9. Dyadic flatness** | Preterm | .093 | .06 | .15 | -.003 | .02 | .87 | -.081 | .18 | .65 |
| | Full term | -.018 | .09 | .84 | .021 | .03 | .45 | -.052 | .15 | .73 |
| Holding at 5 months of corrected age | Preterm | - | - | - | **1.64** | **0.49** | **.001** | 3.37 | 4.39 | .45 |
| | Full term | - | - | - | -.50 | 0.69 | .47 | .67 | 6.17 | .91 |

*SGA=small for the gestational age b= estimated regression coefficient, SE= Standard Error*
*Statistically significant results in bold.*

**Table 5b**. Estimated effects of holding and crying on PCERA scales based on regression analysis at 12 months of corrected age. Effects are adjusted for the infant's gender, SGA, length of ventilator treatment, and group classification (preterm/full term).

| PCERA scales at 6 months of corrected age | Group | Holding 60 min increase/day | | | Fussing & crying 1 bout increase/day | | | Fussing & crying 60 min increase/day | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | B | SE | p | B | SE | p | b | SE | P |
| 1. Maternal positive affective involvement | Preterm | **.101** | **.05** | **.06** | -.027 | .01 | .08 | **-.309** | **.14** | **.03** |
| | Full term | .051 | .08 | .51 | -.015 | .02 | .47 | -.023 | .11 | .84 |
| 2. Maternal negative affect and behavior | Preterm | .015 | .02 | .45 | -.002 | .01 | .74 | .048 | .05 | .37 |
| | Full term | -.004 | .03 | .88 | .000 | .00 | .93 | .001 | .04 | .98 |
| 3. Maternal positive communication | Preterm | .078 | .05 | .15 | -.014 | .01 | .34 | -.228 | .13 | .10 |
| | Full term | .010 | .08 | .90 | .006 | .02 | .77 | -.014 | .11 | .91 |
| 4. Infant's positive affect | Preterm | .106 | .07 | .11 | -.009 | .02 | .62 | -.120 | .17 | .49 |
| | Full term | .131 | .09 | .17 | -.011 | .03 | .68 | .007 | .15 | .96 |
| 5. Infant's sober and withdrawn mood | Preterm | .070 | .05 | .14 | -.007 | .01 | .60 | -.135 | .12 | .28 |
| | Full term | .088 | .07 | .20 | -.017 | .02 | .40 | -.028 | .11 | .79 |
| 6. Infant's quality of play, interest and attention skills | Preterm | .062 | .04 | .12 | .009 | .01 | .42 | -.010 | .11 | .92 |
| | Full term | .081 | .06 | .16 | -.018 | .02 | .27 | -.070 | .09 | .44 |
| 7. Dyadic mutuality | Preterm | **.105** | **.05** | **.06** | .003 | .01 | .85 | -.032 | .014 | .82 |
| | Full term | .068 | .08 | .39 | -.015 | .02 | .52 | -.076 | .12 | .53 |
| 8. Dyadic disorganization and tension | Preterm | **.090** | **.04** | **.01** | .002 | .01 | .82 | .034 | .10 | .72 |
| | Full term | .019 | .05 | .71 | -.012 | .02 | .45 | -.132 | .08 | .11 |
| 9. Dyadic flatness | Preterm | .101 | .06 | .12 | -.009 | .02 | .64 | -.176 | .17 | .29 |
| | Full term | .089 | .09 | .33 | -.017 | .03 | .51 | -.116 | .14 | .41 |

*SGA=small for the gestational age b= estimated regression coefficient, SE= Standard Error*
*Statistically significant results in bold.*

## 5.5 The effect of maternal depression on the mother–infant interaction and on maternal attachment representation classifications

The proportion of maternal depressive symptoms were analyzed both in the larger PIPARI group of preterm infants (n=115) and in the smaller mother–infant relationship group of preterm infants (n=32). The proportion of a high number of depressive symptoms (>12) or a moderate amount of depressive symptoms (10 to 12) was similar in both groups. In the larger study group (n=111), 12.6% of preterm infant's mothers reported a high number of depressive symptoms (> 12) and 16.2% reported a moderate amount of depressive symptoms (10-12). In the smaller group, 12.5% of mothers reported a high number of depressive symptoms (> 12) and 15.6% of mothers reported a moderate amount of depressive symptoms (10-12). In the larger group, the mean EPDS score was 6.67 (SD=5.25), and in the mother–infant relationship study group (n=32), the mean score was 8.25 (SD=5.21).

The estimated differences in the PCERA scales (averaged over two time points) between the mothers with depressive symptoms and mothers with no depressive symptoms in the group of preterm infants are shown in Table 6. Results showed that mothers with depressive symptoms had less maternal positive affective involvement (p=003) and positive communication (p=0.009) in the mother-infant interaction situation than mothers with fewer depressive symptoms. Furthermore, mothers with depressive symptoms had slightly, but not statistically significantly, less dyadic mutuality (p=0.09) and dyadic flatness (p=0.06) in the mother-infant interaction. The number of depressive symptoms was not related to any of the infant scales.

The relationship between the EPDS score and the main three WMCI representation categories (balanced, disengaged and distorted) were calculated in a combined group (n=73) of preterm (n=38) and full term infants (n=45). The results show that the mean score of the EPDS was higher in the mothers classified in the distorted category (M=8.69, SD=6.42) compared to the mothers in the disengaged (M=5.50, SD=3.00) and balanced (M=5.27, SD=3.9) categories ($\chi^2$=6.62, df=2, p=0.04). When the effect of the EPDS score was controlled for, preterm birth was not associated with WMCI classification ($\chi^2$=0.98, df=2, p=0.60).

**Table 6**. Estimated differences between mothers with depressive symptoms and mothers without depressive symptoms in PCERA scales

|  | Estimate | St Error | t | p |
| --- | --- | --- | --- | --- |
| 1. Maternal positive affective involvement | 0.64 | 0.28 | 2.37 | 0.02 |
| 2. Maternal negative affect and behavior | 0.32 | 0.18 | 1.24 | 0.22 |
| 3. Maternal positive communication | 0.80 | 0.30 | 2.86 | 0.008 |
| 4. Infant's positive affect | 0.28 | 0.34 | 0.79 | 0.44 |
| 5. Infant's sober and withdrawn mood | 0.19 | 0.26 | 0.74 | 0.46 |
| 6. Infant's quality of play, interest and att. | 0.30 | 0.22 | 1.34 | 0.19 |
| 7. Dyadic mutuality | 0.55 | 0.32 | 1.83 | 0.08 |
| 8. Dyadic disorganization and tension | 0.35 | 0.25 | 1.53 | 0.14 |
| 9. Dyadic flatness | 0.59 | 0.31 | 2.06 | 0.06 |

## 5.6 Associations between infant's and family background factors and study variables

The infant's medical variables, including birth weight, gestational age, length of hospitalization and 5-minute Apgar scores, did not have an association with the EPDS score, any of the nine PCERA scales, any of the three main WMCI categories, the infant's crying variables or the caregiver's holding variable. Furthermore, family characteristic variables, including parent's age, parent's education and family structure, did not relate to the study variables mentioned above.

A significant association was found between maternal depression and the mother's previous history of mental problems. Mothers with earlier mental health problems had significantly higher EPDS scores at 6 months of the infant's corrected age than mothers who did not have a history of mental health problems (respectively, M=11.1, SD=7.9, M=5.8, SD=4.3, t=3.79, p<0.001). The mother's earlier mental health problems did not associate with any of the PCERA scales or the main WMCI categories.

# 6 DISCUSSION

## 6.1 Strengths and limitations

*Study design, methods and samples*

The present study about the mother–preterm infant relationship has several strengths with regard to the existing literature. A longitudinal design provided a prospective developmental viewpoint on the mother–preterm infant relationship and a possibility to assess the consistency of findings. The longitudinal approach is especially important in populations with a relatively low risk for infant mental health concerns, such as preterm infants. The three assessment points, i.e., 5, 6 and 12 months of corrected age, were chosen to reflect developmentally important phases in the mother-infant relationship and especially in the development of the infant's attachment style. One limitation in the present study design was that there was only one cross-sectional screening of maternal depression. Serial assessments of depressive symptoms would have generated more information about the role of the duration or the timing of depressive features in the mother–infant relationship.

Another strength was the use of the variety of methods, including a semi-structured interview, observation of interaction, self-report diaries and self-report questionnaires. All methods are well validated and widely used. This is the first study where WMCI and PCERA are used together. The combined use of the WMCI (Zeanah et al., 1994) and PCERA (Clark, 1985) methods allowed assessment of different components of the mother–infant relationship at the same age point. Furthermore, the combined use of observation (PCERA and WMCI) and self-report (EPDS and Baby Day Diary) methods raised the reliability of the results. On the other hand, one limitation of the study methods was that maternal depression, crying and affectionate holding were assessed using parental reports, which are susceptible to recording bias. However, the Baby Day Diary has been validated against audio recordings of crying. It also enables the collection of information for a longer period of time than observational data and, therefore, evens out day-to-day variation. In addition, the EPDS has been validated in several studies for use in the evaluation of postnatal depression (Cox, Murray, & Chapman, 1993; Guedeney, Fermanian, Guelfi, & Delour, 1995; Murray, 1992;).

The important strength in the present study was the lack of differences in socioeconomic background and family structure between study groups. The background factors were partly controlled for by the inclusion criteria limiting the sample to native Finnish-speaking mothers and their firstborn singleton infants. Due the equal socioeconomic background and family structure between the study groups, it was possible to study the effect of prematurity

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without confounding variables. However, as the participating families were Finnish and represented upper or middle class status, the results may not be generalizable to more disadvantaged or culturally diverse populations.

In the group of preterm infants, 96% of informed families participated in the study. In addition, all questionnaires were returned and all maternal interviews and videorecordings of mother–infant interaction were completed in both study groups, which make the results more reliable. One limitation of this study was the selection bias in the control group; only 55% of informed families of full term infants participated in the study. On the other hand, it could be assumed that the control group families who agreed to participate were more advantaged, and this should have caused a bias leading to more pronounced differences between groups. However, the selection bias in the control group may explain the lack of depressed mothers in the control group. Therefore, we were not able to assess the difference of the impact of maternal depression on the quality of mother–infant interaction between preterm and full term infants. Another limitation was the relatively small sample size, which did not allow us to divide the group of preterm infants into high-risk and low-risk infants. A larger sample size could have also allowed us to study the relation between interaction and representation separately in the groups of preterm and full term infants. In addition, a larger sample size would have allowed us to analyze background factors as part of the model of the relation between representations and the quality of mother–infant interaction.

This study design does not allow us to determine causal relations, but only associations. However, the influences in the mother–infant relationship are often bidirectional. For example, the present study does not prove a causative relationship between holding and positive interaction. It is possible that there are common underlying factors affecting the mother's behavior towards her preterm infant and the later quality of interaction.

## 6.2 The quality of mother–preterm infant interaction

This study indicated no differences in the quality of mother–infant interaction between preterm and full term infant–mother dyads at 6 months of the infant's corrected age. However, at 12 months of corrected age, preterm infants demonstrated more of a sober and withdrawn mood and a lower quality of play, motor and attention skills than full term infants. The finding regarding the preterm infants' sober and withdrawn mood is consistent with several findings showing that preterm infants are more passive and less alert in dyadic interaction situations (Minde et al., 1985; Muller-Nix et al., 2004) than their full term controls. Furthermore, the result regarding the preterm infant's lower quality of attention, play and motor skills is supported by studies showing more behavioral, cognitive and motor impairments in preterm populations than in full

term infants (Caravale, Tozzi, Albino, Vicari, 2005; Foulder-Hughes & Cooke, 2003; Shum, Neulinger, O'Callaghan, Mohay, 2008).

The finding that differences in the infant's interaction behavior were seen at 12 months but not at 6 months suggests that the development of the infant's own interaction skills contributes more to interaction at a later age, as shown by Muller-Nix et al. (2004) and Gerner (1999). This is also supported by the findings that there were no differences in the maternal or dyadic interaction behavior between the study groups. Therefore, the maternal factors do not explain the differences in infant interaction behavior at 12 months. In addition to the emerging skills of the infant, interaction may be affected by the experiences of the infant related to prematurity, including separation. It is important to be sensitive to these areas of conern in the preterm infant's interaction behavior and affect during clinical follow up with preterm infants. Interventions to enhance the preterm infant's early socioemotional development, such as Theraplay (Jernberg & Booth, 1999), should be in common use in the clinical context when focusing on preterm infant mental health. The interventions should be carried out before the infant reaches 12 months, as this first year is a crucial period in the development of attachment.

The quality of the preterm infant's interaction behavior and affect was not associated with the infant's medical factors, including gestational age, birth weight and length of hospitalization. In future studies, it would be important to more specifically study which infant factors are associated with the preterm infants' lower interaction skills. Furthermore, it would be important to study how the preterm infants' sober and withdrawn mood at 12 months of corrected age is related to socio-emotional development at a later age.

The results regarding the good quality of mother–infant interaction in the preterm population are inconsistent with studies (Forcada-Guex, 2006; Gerner, 1999; Muller-Nix, 2003) showing more areas of concern in dyadic interaction for mothers of preterm infants than for mothers of full term infants. The good quality of maternal and dyadic interaction behavior in our study population may be related to the lack of differences in socioeconomic background and family structure between the study groups. The level of education was high and almost all families were intact in both groups. The background factors were partly controlled by the inclusion criteria limiting the sample to native Finnish-speaking mothers and their firstborn singletons. In several previous studies, the level of socioeconomic status has been lower in the preterm group than in the full term group (Gerner, 1999; Muller-Nix et al., 2004; Schmucker et al., 2005; Wille, 1991). Studies from the full term population have indicated that low socioeconomic status and single parenthood are significant predictors of problems in the mother–infant relationship (Aber, Jone, & Cohen, 2000; Conger & Donnellan, 2007; Kaplan & Pruett, 2000; Seltzer, 1994). In the present study, the inclusion criteria limiting the sample to firstborn singletons

may have biased the sample towards families with more resources. Twin parenthood have shown to be negatively related to the mental health of mothers and fathers during the transition to parenthood (Vilska, Unkila-Kallio et al., 2009). Furthermore, this suggestion is supported by the findings of Cohen and Beckwith (1977) showing that firstborn infants receive more social attentiveness and more responsiveness from their mothers than later-born infants, also in preterm populations. The differences between studies may also due to methodological differences between studies.

Third explanation for the lack of differences between groups in maternal or dyadic interaction may be related to the support for families offered in the neonatal care unit at Turku University Hospital. The parenting support in this unit includes liberal parental visiting policies, active parental involvement in the infant's care, and support from the primary nurse assigned to each infant. Furthermore, the families actively practice Kangaroo Care, providing skin-to-skin contact with the infant. In addition, emotional support is provided for the parents by an infant mental health team as a standard practice. It has been suggested that family-oriented care, parents' frequent visits and Kangaroo Care diminish parental anxiety, increase the parent's confidence as a caretaker, confirm the bonding between the parent and the infant and affect positively infant's later development (Dunn, Reilly, Johnston, Hoopes, & Abraham, 2006; Feldman, Weller, Sirota, & Eidelman, 2002; Griffin & Abraham, 2006; Latva, Lehtonen, Salmelin, & Tamminen, 2004).

## 6.3   Attachment representations in mothers of preterm infants

In the present study, maternal attachment representations distributed statistically similarly into three main categories (balanced, disengaged and distorted) in both study groups showing an equal amount of balanced attachment representations in mothers of preterm infants as in mothers of full term infants. Our result is consistent with previous studies on preterm infant attachment showing similar amount of secure attachment classifications in preterm and full term infants (Brisch, Bechinger, Betzler et al., 2005; Easterbrooks, 1989; Goldberg, Perrotta, & Minde, 1986; Rode, Chang, Nian, Fisch, & Sroufe, 1981).). Furthermore, our result is in line with the study by Brisch et al. (2005) indicating a similar proportion of autonomous attachment representation as assessed by AAI in mothers of preterm infants as in mothers of full term infants. However, this result is inconsistent with the study by Borghini et al. (2006) showing clearly fewer balanced attachment representations as assessed by WMCI in mothers of preterm infants than mothers of full term infants. The important difference between our study and that of Borghini et al. (2006) lies in socioeconomic background. In the Borghini et al. (2006) study, the level of socioeconomic status was lower in the group of preterm infants than in full term infants. Lower socioeconomic status increases the risk for problems for the attachment between mother and infant, especially

in preterm populations (Wille, 1991). The finding indicating no differences in the amount of balanced attachment representations between mothers of preterm and full term infants supports the suggestion that preterm infants and their mothers are as likely to form a secure attachment as full term infants and their mothers.

In spite of the similar distribution into three main representation categories, there were qualitative differences in the representations between the study groups. The mothers of preterm infants had less coherence and acceptance and more unrealistic fears for the infant's safety in their representations than the mothers of full term infants. The lower coherence in the maternal representations may be related to the interrupted development of the representations during pregnancy, the traumatic experience of the birth and fear for the infant's survival. The lower acceptance in the maternal representations may be caused by the contrast between the mother's idealized representations of the infant during pregnancy and her representations of the real preterm infant with developmental vulnerabilities. The finding about the higher prevalence of unrealistic fears for the infant's safety is in line with results showing a more overprotective parenting style in the group of preterm infants (Wightman, Schluchter, Drotar et al., 2006). The low level of acceptance and a high amount of unrealistic fears for the infant's safety in the maternal representations may develop into a problematic parenting style, where the parent has difficulties in recognizing the infant's strengths and need for independence. This may form a risk for the mother–child relationship and for the child's later socio-emotional development. Therefore, these distortions in the maternal representations should be taken into account in the clinical context, when therapeutic treatments for the mother–preterm infant relationship are being planned.

On the other hand, it has also been suggested that the mother's emotional arousal and overprotectiveness, including fear about the preterm infant's welfare and future development, can paradoxically encourage parental involvement (Borghini et al., 2006). This is supported by findings showing less risk-taking behavior, including alcohol and drug abuse and illegal behavior, in adolescents who were born preterm compared to the adolescents who were born full term. This finding suggests that a lack of risk-taking behavior is related to increased parental monitoring of very-low-birth-weight children (Hack, Flannery, Schluchter, Cartar, Borawski, & Klein, 2002).

## 6.4 The mother–infant interaction and maternal attachment representations

The present study indicated that maternal attachment representations are related to several elements of mother–infant interaction behavior in the groups of preterm and full term infants. This finding is in accordance with the model of

the organization of the mother–infant relationship in which the relationship is seen as an open system including components of the mother's and the infant's mental representations on the one hand and the objective interaction behaviors of the mother and the infant on the other (Stern-Brushweiler & Stern, 1989). The relation between subjective representations and observable interaction behaviors were similar in the groups of preterm and full term infants. Consequently, we suggest that the organization of the mother-infant relationship need not seem to be affected by the preterm birth.

Interestingly, the connection between representation classification and interaction behavior was seen in all elements of interaction: that is, in the scales of the parent, the infant and the dyad and the parent. The relation between maternal interaction scales and maternal attachment representations was an expected result, as we know from previous studies and theories that maternal representations are related to maternal interaction behavior in caregiving relationships (Stern, 1995; Zeanah & Benoit, 1995). The maternal representation classification was associated with all three of the infant's interaction scales, which included behavioral, developmental and emotional patterns in the infant's interaction. This raises an interesting question: to what extent do the mother's attachment representations direct the infant's development. However, our results do not prove a causative relationship between maternal representations and the quality of mother–infant interaction. The infant's own characteristics, such as developmental level and biological traits, may also affect the mother's representations.

The results presented earlier showed that preterm infants more frequently demonstrated a sober and withdrawn mood and had lower quality of attention, play and motor skills in the interaction situation than full term infants. Furthermore, the present study has shown that mothers of preterm infants have less coherence and acceptance and more fear for the infant's safety in their representations. As the representations and the infant's interaction variables were related to the each other, it can be suggested that the deficits in the infant's interaction behavior are associated with the lower acceptance and the higher amount of unrealistic fear in the mother's representations. In the clinical context, it is important to be sensitive to this kind of relationship model, where the infant's developmental deficits and the infant's sober mood are related to the parent's overprotectiveness and difficulty accepting the infant's characteristics, as this style may form a risk for the infant's socio-emotional development.

The dyadic interaction was more mutual and organized and less tense in the group of mothers with balanced attachment representations at both age points compared to the mothers with a non-balanced representation classification. This indicates that a mother's positive subjective experience of the infant also positively affects quality of dialogue, mutuality and reciprocity in mother–infant interaction. On the other hand, the dyadic interaction can be challenging due to

negative characteristics of the infant, such as a difficult temperament, and this may negatively affect the mother's representation of the infant and their relationship (Mäntymaa, 2006). Interestingly, the mothers with non-balanced attachment representations had more concern scores in the dyadic variables in the PCERA but not in the infant's or in the parent's variables. Overall, the dyadic interaction scales have shown to be the most predictive PCERA scales in the present sudty. The dyadic scales were more strongly related also to the caregiver's holding than the infant and maternal interaction scales. This confirms the suggestion that the crucial part of the mother–infant relationship is the dyadic interaction (Mäntymaa, 2006). Furthermore, the findings support the suggestion that the mother's representations of the infant and her representations of herself as a mother are not necessarily separate constructs, but are merged into one representational unit that includes experiences about the self as a caregiver and about the infant as a recipient of care, and thus about the dyad as a working attachment partnership suggestion (Solomon and George, 1999, 2000).

Altogether, the associations between maternal representations and maternal, infant and dyadic interaction patterns confirm the methodological value of the WMCI (Zeanah et al., 1994) and PCERA (Clark, 1985) methods. The results regarding the relationship between interaction and representations suggest that using the PCERA (Clark, 1985) method provides detailed information about those interactional patterns that affect the development of maternal representations and also infant's attachment. Furthermore, the present results suggest that WMCI classification is an accurate method for capturing those maternal representations about the infant and the mother-infant relationship that affect mother–infant interaction. In clinical practice, it would be valuable to evaluate the observed mother-infant interaction and maternal representations together.

## 6.5 Factors affecting the mother–preterm infant relationship

### 6.5.1 Infant's medical factors and socioeconomic background

Interestingly, the infant's medical factors, including gestational age, birth weight, length of ventilator treatment or SGA, were not related to the quality of mother–infant interaction, to maternal depression or to maternal attachment representations in our preterm population. This is in contrast with findings of more areas of concern in mother–infant interaction (Minde et al., 1985; Muller-Nix et al., 2004) and more maternal depression (Singer et al., 1999) in high-risk than low-risk preterm infant groups. On the other hand, there are also studies showing that mothers of high-risk preterm infants are emotionally more involved (Greenberg & Crnic, 1986) in interaction situations and have more balanced attachment representations (Borghini et al., 2006) than mothers of low-risk preterm infants. Because of the small group size in the present study,

subtle differences could have been missed due to type beta error. On the other hand, this finding gives further support to the suggestion that family-oriented neonatal care including, for instance, Kangaroo Care, even for high-risk preterm infants, a high level of parental education and a supportive family structure may diminish the effect of neonatal factors on the quality of the mother–infant relationship in preterm populations.

The quality of mother–infant interaction, maternal depression and maternal attachment representations were not related to the parents' length of education or age or to family structure in either group. The variability of the parents' education level and the family structure was small. Therefore, the high level of education and high socioeconomic status and the homogeneity of our population might explain why socio-demographic factors did not relate to maternal depression and the quality of the mother–infant relationship.

## 6.5.2 Preterm infant's crying and caregiver's holding behavior

The preterm infants did not differ from the full term infants in the duration of crying at 5 months of corrected age. This indicates that preterm infants have no more prolonged crying at this age point than full term infants. The duration of crying at 5 months of corrected age associated negatively with maternal positive affective involvement at 12 months of corrective age only in the group of preterm infants. This result is in line with previous findings in full term populations showing that prolonged crying decreases parental emotional involvement in the interaction situation (van den Boom & Hoeksma, 1994; Räihä, Lehtonen, Korhonen, & Korvenranta, 1996). Mothers of preterm infants may be even more vulnerable to the impact of prolonged crying, resulting in less involvement in interaction situations.

In spite of the finding that there were no differences in the duration of crying between study groups, preterm infants cried more often than full term infants. The frequency of crying bouts was not related to the quality of mother–infant interaction in the either group at either age point, but it was related positively to the duration of holding in the preterm group. Those preterm infants who cried more often were also held more. Based on these results, it can be suggested that prolonged crying is a risk factor for mother–infant interaction. In contrast, frequent but soothable crying may have a protective role in mother–infant interaction, through triggering more affectionate holding. The frequency of crying bouts in preterm infants may be a sign of vigor and robustness. This suggestion is in line with the findings of Beckwith and Rodning (1998) showing that preterm infant crying was associated positively with maternal responsiveness and the infant's later competence.

Interestingly, the duration of holding at 5 months of corrected age was associated positively with the quality of mother–infant interaction between

preterm infants and their mothers. Our study showed that the amount of holding in the home environment was associated with the infant's positive affect at 6 months of corrected age, and with a good quality of dyadic interaction at 6 and 12 months of corrected age. This finding is supported by previous studies showing the positive effects of physical contact after infant's birth and touch interventions during the neonatal intensive care period on the mother–infant relationship (Feldman, Feller, Sirota & Eidelman, 2002; Ferber, Feldman, Kohelet et al., 2002; Latva, Lehtonen, Salmelin & Tamminen, 2009).

The relationship between more frequent crying bouts, a longer duration of caregiver holding and a good quality of mother–infant interaction in the preterm population suggests that mothers of preterm infants have a different kind of caregiving style that affects the mother–infant relationship. In a preterm dyad, the crying may be a trigger for the holding, and thus form a kind of "bridge" to a more mutual synchronization in the mother–infant relationship. This is in line with findings showing that mothers of preterm infants are more sensitive to the infant's negative behavior and that they do not experience the infant's crying as negatively as mothers of full term infants. In some previous studies (Minde et al., 1985; Muller-Nix et al., 2004), it has been suggested that compensatory caretaking styles in mothers of preterm infants, including more vocalization, higher activity and physical caretaking, pose a risk for the quality of mother–infant interaction. However, the findings in the present study suggest that the different caretaking style, including more maternal holding of preterm infants, may be a protective model for the mother–preterm infant relationship. Compensatory mechanisms may make the emotional interchange between the mother and preterm infant comparable to that in the full term dyad.

### 6.5.3 Maternal depression

In our study population of preterm infants, 12.6% of mothers had symptoms of depression at 6 months of the infant's corrected age. This is less than in other studies of maternal depression in preterm populations, which show a prevalence ranging between 30% to 60% (Davis et al., 2003; Nagata, Nagai, Sobajima, Ando & Honjo, 2004; Singer et al.,1999. The postnatal timing of depression assessment may contribute to this difference, as many studies have assessed the maternal depression during the first four months after birth (Davis et al., 2003; Singer et al.,1999). The prevalance of maternal depressive symptoms (12.6%) in our preterm population is in line with recent Finnish studies, where the prevalence of postnatal depression has varied from 7% to 13% during the first six months after birth in mothers of full term infants (Hiltunen et al., 2004; Luoma et al., 2004; Tammentie et al., 2004).
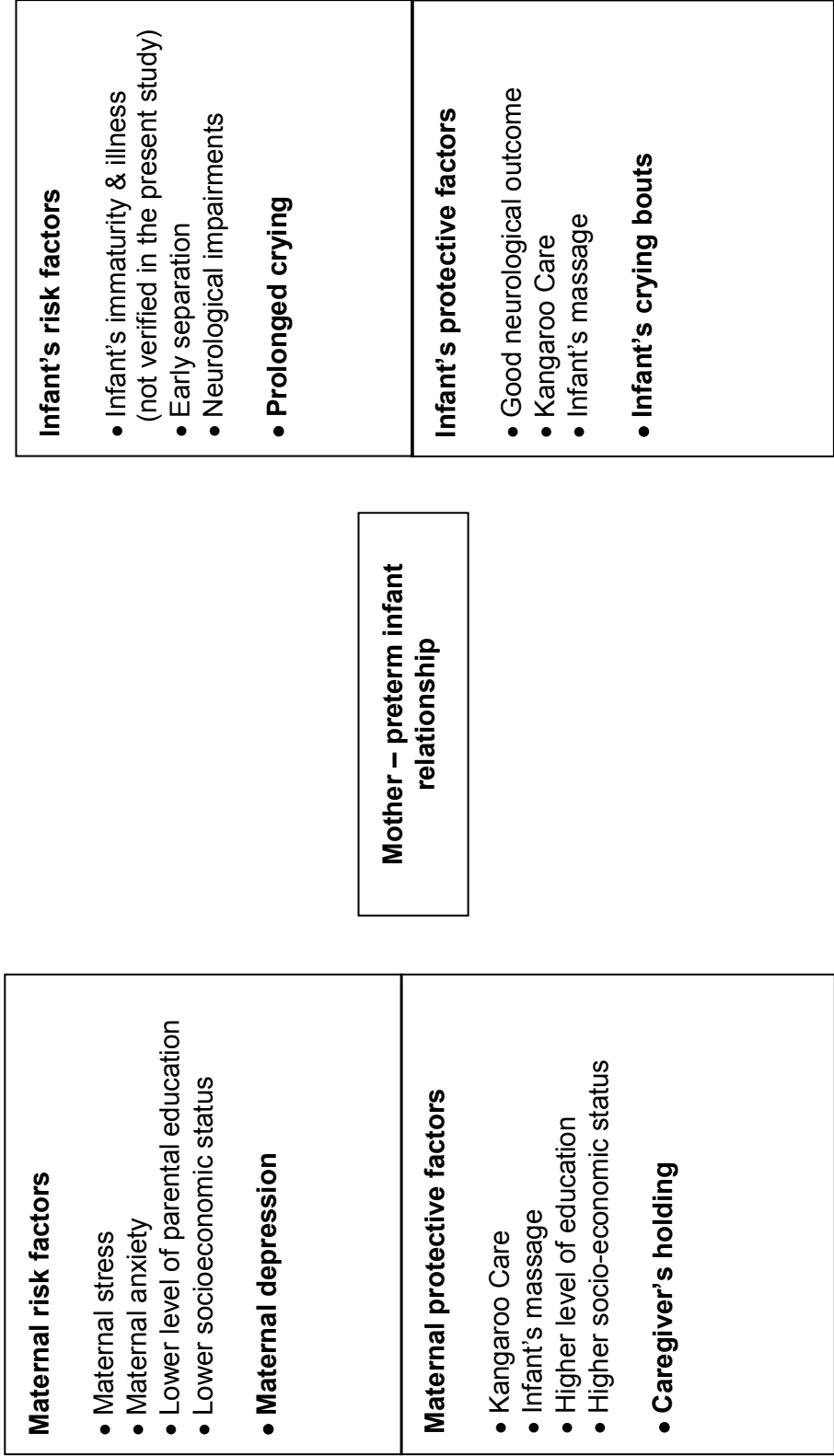
Furthermore, results showed that maternal depression was not related to infant's medical condition or family characteristics of preterm infants in contrast with previous findings showing that maternal depression associated with

mother's lower education and infant's poor medical condition (Davis et al. 2003; Singer at al.1999). However, Finnish studies of mothers of full term infants also showed no relation between maternal depression and family characteristics (Hiltunen, Jokelainen, Ebeling, Szajnberg, Moilanen, 2004; Luoma, Tamminen, Kaukonen et al., 2001). The lack of association between maternal depression and socio-demographic factors in Finnish cohorts may be explained by homogeneity of our population, but also may be caused by Finland's effective system of well-baby clinics.

In the present study, maternal postnatal depression was more common in mothers with a history of mental health problems. This finding is consistent with several earlier studies on mothers of full term infants showing that maternal postnatal depression is related to the mothers' previous experience of depression or other mental disorders (Campbell et al., 1992; O'Hara, 1994). There was a comparable prevalence of previous mental health problems in the mothers of full term infants, but there were no cases of maternal postnatal depression in the full term group at 6 months of the infant's corrected age. This may suggest that previous mental health problems and preterm birth together raise the risk for the postnatal maternal depression. On the other hand, we cannot exclude the possibility that mothers with postnatal depression did choose not to participate in the study as controls.

Maternal depression was related to the quality of maternal interaction behavior in the group of preterm infants and their mothers. Mothers who had depressive symptoms had less positive affective involvement and communication in the interaction situation, when the child was at 6 and 12 months of corrected age. Furthermore, mothers with distorted representations had more symptoms of depression than mothers with disengaged or balanced representations. Therefore, maternal depression may affect mother–infant interaction through distorted maternal representations. This finding is consistent with several previous studies of full term infants showing that depressed mothers are more passive and less emotionally involved in interaction than non-depressed mothers and have more non-balanced attachment representations (Murray, 1992; Murray, Fiori-Cowley, Hooper, & Cooper, 1996; Wood, Hargreaves, & Marks, 2004). Furthermore, maternal depression has been shown to have long-term effects on the infant's development that are mediated through the mother–infant relationship (Cogill, Caplan, Alexandra, Robson, & Kumar, 1986; Murray, 1992). Therefore, it is essential to screen for maternal depression still after NICU period during follow-up with preterm infants and their mothers and to offer focused support for the mother–infant relationship in addition to the treatment of maternal depression. The treatment is especially important when the depression continues after the first months of the infant's life.

**Figure 5.** Factors affecting the mother–preterm infant relationship based on the present and previous studies. Findings from the present study are bolded.

**Maternal risk factors**

- Maternal stress
- Maternal anxiety
- Lower level of parental education
- Lower socioeconomic status

- **Maternal depression**

**Maternal protective factors**

- Kangaroo Care
- Infant's massage
- Higher level of education
- Higher socio-economic status

- **Caregiver's holding**

**Mother – preterm infant relationship**

**Infant's risk factors**

- Infant's immaturity & illness (not verified in the present study)
- Early separation
- Neurological impairments

- **Prolonged crying**

**Infant's protective factors**

- Good neurological outcome
- Kangaroo Care
- Infant's massage

- **Infant's crying bouts**

## 6.6   Summary and conclusions

The present study indicated no differences in maternal or dyadic interaction behavior between preterm and full term infants and their mothers. Furthermore, no differences were found in the amount of balanced attachment representations between mothers of preterm and full term infants. Interestingly, the duration of the caregiver's holding behavior was positively related to the frequency of crying bouts and to the quality of mother–infant interaction only in the preterm population. The present study also indicated that preterm infants demonstrated more sober and withdrawn mood and lower quality of play, attention and motor skills in interaction situations. Furthermore, mothers of preterm infants had less coherence and acceptance and more unrealistic fears for the infant's safety in their attachment representations than in the controls. In addition, prolonged crying and maternal depression were shown to be risk factors for mother –infant interaction in preterm population. Factors affecting the preterm infant–mother relationship based on the present and previous studies are presented in Figure 5.

The equality of socioeconomic and family background factors between the preterm and full term groups might explain the lack of differences in maternal representation classifications and interaction behavior between the groups. In addition, the family-oriented neonatal care at Turku University Hospital may be partly related to the good quality of the mother–infant relationship in the preterm population.

The associations between frequent crying bouts, the duration of holding and the quality of mother–infant interaction support the suggestion that the infant's crying may be a trigger for holding and thus for positive, mutual and reciprocal interaction. This suggests that mothers and their preterm infants develop a different kind of interaction style. This may be an adaptive mechanism protecting the mother–infant relationship, as there were no differences in maternal interaction or attachment representations between the study groups.

The results of the present study suggest that prematurity, in and of itself, does not pose a risk for the development of maternal attachment or dyadic interaction. However, preterm birth together with other risk factors, including maternal depression, the infant's prolonged crying and the mother's history of mental health problems, may be an additional risk factor for the maternal attachment and dyadic interaction.

In the clinical context, it is essential to screen for and uncover the risk factors that have been indicated in the present study. Consequently, if maternal depression, prolonged crying or deficits in the preterm infant's interaction behavior are noticed during neonatal intensive care or developmental follow-up, a detailed assessment should be carried out, including both behavioral and

subjective components. As the risk factors influence all of the inter-related components of the relationship, a holistic approach to the assessment is vital to accurately and effectively focus the treatment of the mother–infant relationship. Early interventions to enhance the preterm infant's own emotional and social development should be in common use in the clinical context when focusing on infant mental health.

The results of the present study also underline the importance of the caregiver's physical closeness for the quality of the mother–infant interaction in preterm populations. Therefore, it would be important to encourage parents to use Kangaroo Care to support a model of positive physical closeness with their preterm infants.

## 6.7   Future research

In future studies, it would be important to evaluate treatment interventions to support the organization of the mother–preterm infant relationship when the relationship is threatened by significant additional risk factors, such as maternal depression and prolonged infant crying. As depression seems to be an important risk factor, there is a need to have more detailed information about the critical timing and duration of depression and, most importantly, effective treatments of depression to protect the mother–preterm infant relationship. Furthermore, there is a need to study and develop family-centered neonatal care from the perspective of the development of the mother–preterm infant relationship

In addition, it would be important to study the socio-emotional outcome of preterm infants during early childhood in greater depth. Specifically, those factors that might explain the preterm infant's sober and withdrawn mood in the interaction situation at 12 months should be explored in greater detail. In addition, it would be important to study how a sober and withdrawn mood at 12 months is related to later socio-emotional development.

Another big challenge for future research is to study the father–preterm infant relationship. The father's supportive role may be even more pronounced when the infant is born prematurely. Due to the increased maternal anxiety and stress caused by the preterm birth, the father may take on a more active and supportive role, not only as a support for the mother, but also as a caretaker of the preterm infant. This hypothesis is supported by a study in which the fathers of preterm infants had more favorable interaction scores than those of full term controls, whereas the mothers of preterm infants had lower scores than their full term controls (Harrision, 1999). The significance of the fathers in the preterm infant's mental development needs to be elucidated to recruit the potential of the fathers in the optimal way.

# 7   ACKNOWLEDGEMENTS

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# APPENDIX

## PCERA scales and items

| PC-ERA Factors | Scale items | | α 6 m | α 12 m |
|---|---|---|---|---|
| | Maternal component | | | |
| 1. Maternal positive affective involvement | 2. Expressive voice tone <br> 3. Warm, kind voice tone <br> 4. Expressed positive affect <br> 7. Lack of depressed, withdrawn mood <br> 9. Enthusiastic <br> 12. Enjoyment <br> 13. Positive physical contact <br> 19. Contingent response to child's positive beh. <br> 23. Connectedness <br> 24. Mirroring | (6 and 12 months) <br> (6 and 12 months) <br> (6 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> ( 6 months) | .89 | .88 |
| 2. Maternal negative affect and behavior | 1. Angry voice tone <br> 5. Expressed negative affect <br> 6. Angry, hostile mood <br> 11. Displeasure <br> 20. Contingent response to child's negative beh. | (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) | .82 | .91 |
| 3. Maternal positive communication | 15. Visual contact <br> 16. Amount of verbalization <br> 17. Quality of verbalization <br> 18. Social initiative <br> 21. Structures & mediates environment <br> 22. Parent reads child's cues and responds <br> 24. Mirroring <br> 26. Creativity | ( 6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 months) <br> (6 and 12 months) | .83 | .87 |
| | Infant component | | | |
| 4. Infant's positive affect | 32. Happy, pleasant mood <br> 33. No apathetic mood <br> 36. No sober/serious mood | (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) | .84 | .88 |
| 5. Infant's sober and withdrawn mood | 32. Lack of happy, pleasant mood <br> 33. Apathetic, withdrawn mood <br> 36. Sober/serious <br> 39. Lack of social initiatives <br> 40. Lack of responses to parent social initiatives <br> 41. Avoiding/averting <br> 53. Passivity <br> 55. Lack of visual contact | (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) | .82 | .79 |
| 6. Infant's quality of play, interest & attention skills | 33. No apathetic, withdrawn mood <br> 38. Alertness <br> 39. Social initiative <br> 40. Social response <br> 44. Motoric competence and quality <br> 45. Quality of exploratory play <br> 46. Attentional abilities <br> 47. Robustness <br> 48. Persistence <br> 50. Self-regulation/organization <br> 55. Visual contact <br> 56. Communicative competence <br> 57. Readability | (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) | .89 | .78 |
| | Dyadic component | | | |
| 7. Dyadic mutuality | 59. No flat, empty, constricted affect <br> 61. Enthusiasm, joie de vivre <br> 63. Reciprocity <br> 65. State similarity | (6 and 12 months) <br> (6 months) <br> (12 months) <br> (6 and 12 months) | .77 | .73 |
| 8. Dyadic disorganizatio and tension | 58. Anger, hostility, irritability <br> 60. Tension, anxiety <br> 62. Lack of joint attention <br> 64. Lack of dyadic organization/regulation | (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) <br> (6 and 12 months) | .75 | .72 |
| 9 Dyadic flatness | 59. Flat, empty, constricted affect <br> 61. Enthusiasm, joie de vivre <br> 62. Joint attention, activity <br> 63. Reciprocity | (6 and 12 months) <br> (6 months) <br> (6 and 12 months) <br> (12 months) | . 76 | .78 |